Streamside Tailings Operable Unit
Silver Bow Creek / Butte Area NPL Site

Final Design Report

Remedial Action
Subarea 1
Reach A

Volume II
Appendices B-L

June 1999

Montana Department of Environmental Quality

U.S. Environmental Protection Agency

MAXIM Technologies Inc
Reclamation Research Unit

INTER-FLUVE,INC.
Bighorn Environmental

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APPENDIX B

GROUNDWATER DEWATERING

Final Design Report - Reach A Subarea 1
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SEDIMENT DETENTION PONDS SIZE CALCULATIONS

The guidelines from the *Montana Sediment and Erosion Control Manual* (MDEQ, 1996) were used to size the sediment detention ponds. The sediment detention ponds will detain sediment from the discharge of the groundwater dewatering trenches during the construction of the trenches. Once construction of a given trench is complete, the discharge will be rerouted to the stream diversion channel or stream channel. The data from the *Draft Pilot Test Construction Monitoring Report* (Maxim and Inter-Fluve, 1998) show that sediment was not a problem after the construction of the trenches was complete.

Based on the results in the *Draft Pilot Test Construction Monitoring Report* (Maxim and Inter-Fluve, 1998), it is assumed that the maximum in-flow into the groundwater trenches will be 50 gpm per 100 feet of trench. The specifications for the pump capacities are based on this assumption, and therefore, the sizes of the sediment detention ponds are based on this flow rate.

As shown by the calculations on the following two sheets the sediment ponds need to have a surface area of 139 square feet per 100 feet of groundwater dewatering trench. This unit flow rate was then applied to each sediment detention pond based on the longest trench which will discharge to the given pond.

References:

Maxim Technologies, Inc. and Inter-Fluve, Inc. 1998. Draft Pilot Test Construction Monitoring Report, Subarea 1 Remedial Design, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area NPL Site. Prepared for Montana Department of Environmental Quality and U.S. EPA. January 1998.

Montana Department of Environmental Quality, 1996. Montana Sediment and Erosion Control Manual. Revised May.

MAXIM TECHNOLOGIES INC

BY Cameron Beul DATE 2/11/98

JOB TITLE SST Design JOB NUMBER 9731701-190

SUBJECT Groundwater Dewatering Sed. Pond Size SHEET 1/2

Develop general criteria relating discharge flowrate to sediment detention pond size.

Use $SA = \frac{1.2Q}{V}$ * where SA = Surface Area
Q = design inflow
V = 0.00096 ft/sec settling velocity of a medium silt (0.02 mm)

Since the design criteria for the pumps are 50 gpm per 100 feet of trench, the design criteria for the pond sizing will be based on 50 gpm.

$$SA = \frac{1.2 \times 50 \text{ gal}}{\text{min}} \times \frac{1}{0.00096 \text{ ft}} \times \frac{\text{sec}}{1 \text{ min}} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{\text{ft}^3}{7.481 \text{ gal}} = 139 \text{ ft}^2$$

139 ft² per 50 GPM or 100 ft

Additional criteria:

* Minimum depth of 2' for settling
* 3:1 side slopes
* 6:1 aspect ratio between length + width is preferable

* from: Montana Sediment + Erosion Control Manual, MDEQ, May, 1996.

MAXIM TECHNOLOGIES INC

BY Cameron Beul DATE 4/8/98

JOB TITLE SSTOU-GW Dewatering JOB NUMBER 9731701-190

SUBJECT Open Space in Sump Pipes SHEET 1/1

Groundwater and Wells (Driscoll, 1986) recommends a maximum entrance velocity of 0.1 ft/s for the design of wells. This recommendation is based on friction losses, rates of incrustation, and corrosion.

For 100 ft of trench, max. design flow is 50 gpm. Therefore the open space required for 100' of trench for an entrance velocity of 0.1 ft/sec is

$$A = \frac{Q}{V} = \frac{50\,gal}{\cancel{min}} \times \frac{\cancel{sec}}{0.1\,\cancel{ft}} \times \frac{\cancel{min}}{60\,\cancel{sec}} \times \frac{\cancel{ft^3}}{7.481\,gal} \times \frac{144\,in^2}{\cancel{ft^2}} = 160\,in^2$$

Max. Trench length = 1000 ft $\Rightarrow$ 1600 in^2 open space unreasonable for a pipe height of 2-4'

Use entrance velocity of 0.4 ft/s

$$A = \frac{160\,in^2}{4} = 40\,in^2 \text{ open space/100' of Trench}$$

MAXIM TECHNOLOGIES INC

BY C. B. DATE 3/4/98

JOB TITLE SST Design JOB NUMBER

SUBJECT GW Dewatering Sed. Pond Size SHEET 2/2

Sizes for specific sediment detention ponds. The sizes are based on the 139 ft²/100' Trench criteria developed on the previous page and longest length trench which will use the specific pond.

Sed Pond	Trench	Trench Length (ft)	Surface Area Required (ft²)	Pond * Length (ft)	Pond * Width (ft)	Actual Surface Area (ft²)
SPA	T1	395	549	60	10	600
	T2	320				
SPB	T3	40				
	T4	400	556	60	10	600
SPC	T5	858	1,193	90	15	1,350
	T6	460				
	T7	349				
	T8	274				
SPD	T9	995	1,383	96	16	1,536
	T10	692				
SPE	T11	561	780	72	12	864
	T12	475				
SPF	T13	848	1,179	90	15	1,350
	T14	280				
	T15	727				

* Note: The lengths & widths are for the water surface when it is at the elevation of the top of the outlet pipe. The lengths and widths shown on plan sheet are 6 feet longer because they are the dimensions for the top of berm which is one foot higher than the outlet. With a 3:1 slope on both sides, this results in an additional 6 feet.

APPENDIX C

STREAM DIVERSION AND DEWATERING

Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

Appendix C

Stream Diversion and Dewatering

C-1 Diversion Structure

Technical Memo and Associated Calculations: Diversion Structure

C-2 Diversion Channel

Technical Memo and Associated Calculations: Diversion Channel Embankment (Berm) and Channel Lining

Technical Memo and Associated Calculations: Erosion Protection and Grade Control at Downstream End of Diversion Channel and Reach A

Technical Memo and Associated Calculations: Diversion Channel Haul Road Crossings

HEC-RAS Output for Diversion Channel, Design Conditions

C-3 Upstream Reach A Dewatering (Above Diversion Structure)

Technical Memo and Associated Calculations: Upstream Reach A Dewatering System

Technical Memo and Associated Calculations: Cofferdam Analysis

Technical Memo and Associated Calculations: Upstream Reach A Jersey Barrier Dewatering Analysis

APPENDIX C-1

Diversion Structure

Memorandum

To: SSTOU, Subarea 1, Reach A Design
From: Dale White
Date: April 6, 1998
Regarding: Diversion at head of diversion channel, Subarea 1

The goals of the diversion structure design were to: a) allow lower flows (approximately 0-50 cfs) to remain in the reconstructed channel, b) shunt higher discharges into the diversion channel, and c) allow greater than 10-year flows to spill back into the reconstructed channel, thus reducing the chance of overload of the diversion channel. To accomplish these goals, a three-stage scheme was devised using culverts, a spillway, and adjustments of diversion channel bed elevation and cross-sectional geometry. The resulting structure will allow flows of 0-35 cfs to remain in the reconstructed channel. These flows will be conveyed through the diversion structure in two 30" diameter culverts. At flows exceeding about 35 cfs, a portion of the flow will be diverted into the diversion channel. When the diversion channel discharge surpasses approximately 550 cfs, a portion of its flow will exit by way of the spillway and re-enter the reconstructed channel. The diversion channel and diversion structure are designed to perform in this manner for discharges up to the 50-yr event of approximately 1042 cfs. If the 50-yr event is surpassed, it is possible that the diversion channel will be overtopped and will incur damage. A table showing the predicted apportionment of flows at the diversion structure is attached.

Design methodology

Hec-Ras hydraulic modeling was used extensively in diversion structure design. The procedure followed the following steps.

- Hec-Ras was used to create a relationship between upstream water surface elevation (WSEL) and discharge for the culverts (see attached table).
- Hec-Ras was used to create a relationship between the WSEL immediately upstream of the spillway (at diversion channel station D1+46) and the discharge of the spillway (see attached table). The spillway was modeled in two ways: using the "weir" function of Hec-Ras; and by describing the spillway using conventional cross-sections. The latter method resulted in slightly more conservative results, which were used in this analysis.
- A model of the diversion channel was used to calculate diversion channel water surface elevations for a given discharge.

- Spillway flow was estimated based on the water surface elevation at diversion channel station D1+46. One-half of the expected flow loss at the spillway was removed from the model at each of the two stations D1+46 and D 1+66. These stations lie approximately at the midpoint and downstream portions of the spillway, respectively.
- With the expected spillway losses incorporated, the diversion channel model was re-run to determine a more accurate water surface elevation at D1+46 (see attached table). The spillway rating curve was again consulted, and the spillway losses were again incorporated into the diversion channel model. This iterative procedure usually converged on a common WSEL after 3-4 iterations. [Note: The elevation of the EGL (energy grade line) is often used as the point of convergence in split flow problems. In this case, however, it was assumed that most of the kinetic energy of the water, which is what makes up the difference between the WSEL and EGL, would not be conserved due to the right angle exit of the spillway.]
- Once the diversion channel and spillway flows were balanced properly, the diversion channel model was used to calculate the WSEL at station D0+00. This WSEL, which corresponded to the upstream WSEL of the culvert rating curve, was used to determine the culvert discharge.

This analysis yielded the attached table titled "Apportionment of Silver Bow Creek discharge at diversion structure."

Hec-Ras model input

The following roughness* and energy loss coefficient values were used in the Hec-Ras models:

Diversion channel roughness:	0.035
Spillway roughness - shallow flow (spillway model):	0.1
Culvert roughness (culvert model):	0.015
Culvert entrance loss coefficient (culvert model):	0.9**
Culvert exit loss coefficient (culvert model):	1.0

*Reference for roughness values - *Design of Roadside Channels with Flexible Linings*, FHWA, HEC-15.

**CMP culvert projecting from fill - assume simple proposed headgate (see Drawings) has same inlet loss coefficient.

Culverts

The two 30-inch diameter culverts were chosen because: they are large enough to readily pass lower flows; and they are small enough to force a large

proportion of higher Silver Bow Creek discharges into the diversion channel. Attached sheets show discharge vs. headwater depth for this culvert emplacement (inlet invert elevation is 5408.6). Head gates at the culvert inlets will allow for all water to be diverted out of the re-constructed channel during construction. Protection from scour at culvert outlets was designed using USDOT methodology presented in their Hydraulic Engineering Circular (HEC) 11. A 1.5 ft gabion mattress thickness was selected using velocity-based design criteria (attached) and an estimated outlet velocity of 11.2 ft/sec at the 50-yr discharge (see attached Hec-Ras culvert output). Although the attached design criteria does not address velocities over 10 cfs (with silty or sandy soils), the use of 1.5 ft thick gabions with filter fabric placed beneath them is expected to provide sufficient protection should the 50-yr event occur. To protect against bed degradation as flow contracts near the culvert inlets, 1 ft thick gabion mattresses will be installed in this location.

Diversion channel inlet

The diversion channel inlet invert was designed approximately 2.4 feet above the adjacent re-constructed channel invert. This configuration allows flows of 0-35 cfs remain in the re-constructed channel. The inlet was designed with a 15 feet bottom width, a bottom elevation of 5411.0, and 2:1 side slopes. The 15 feet bottom width allows for a reduction in the height of the berm constructed to create the diversion. The wider bottom width and reduced berm height decreases materials quantities required to construct the berm, and reduces the slope and/or length of the spillway directing flood flows (exceeding a 10-year event) back to the re-constructed channel and floodplain.

Spillway

The spillway crest elevation was placed at the Hec-Ras water surface elevation for the diversion channel's portion (about 550 cfs) of the 10-year flood flow. The crest elevation is 5415.1 at station D1+00 and slopes to 5415.0 at station D1+60. A Hec-Ras model was constructed in order to create a rating curve for spillway discharge (relating it to upstream WSEL) and for use in spillway surface armor design. Results of these analyses indicated that the relatively small riprap available would not be sufficient as armor, but that gabion structures would provide adequate protection. Again using HEC-11 design methodology, gabions were designed to protect the spillway surface, the toe of the spillway slope, and the re-constructed channel bed immediately below the spillway. A description of the gabion sizing procedure is attached.

Diversion channel drop area

An additional element of the HEC-RAS diversion channel model was an abrupt drop in the diversion channel bed and an abrupt contraction of the diversion

channel side slopes to transition from a 15 feet bottom width to a 6 feet bottom width. This change in channel cross-section was modeled between stations D1+72 and 1+84. Final design required the drop to be moved 10 ft downstream, between stations D1+82 and 1+94. This change will not result in appreciable changes in the Hec-Ras results. Results of the final Hec-Ras diversion channel model, run at 610 cfs throughout its length (for channel lining design) and at flows corresponding to the 50-yr Silver Bow Creek discharge (for channel capacity design) are included in the Appendices.

Height of diversion structure berms

The top height of the diversion structure berm was set at the predicted water surface (given the flow apportionment discussed above) for the 50-yr flow in Silver Bow Creek plus an additional 0.4 ft to account for expected superelevation of flow as it is turned into the diversion channel mouth. The top of berm elevation will be 5417.3. Calculations of expected superelevation are attached.

Diversion structure berm structural stability

The diversion structure berm will lie upon newly installed flood plain material. To provide a stable foundation for the berm, installed floodplain material will be installed in lifts and compacted in all areas which will eventually underlie the diversion structure berm. Lift height and compaction requirements are given in the Specifications. Similarly, all berm material will be installed in lifts and compacted as described in the Specifications.

The diversion structure berm was analyzed for slope stability and sliding stability. The following assumptions were made about the berm material.

- Silty sand (SM)
- Unit weight = 125 lb/ft2
- Friction angle (phi) = 30°
- Cohesionless soil (c = 0)

Slope stability analysis yielded a safety factor of 1.7, while the sliding stability analysis resulted in a safety factor of 3.3 (see attached sheets).

Silver Bow Creek SSTOU, Subarea 1, Reach A Design
D. White, 4/6/98

Apportionment of Silver Bow Creek discharge at diversion structure

Silver Bow Cr. discharge (cfs)	Approximate Return Pd. (yr)	Culvert Discharge (cfs)	Spillway Discharge (cfs)	Ditch Dicharge (cfs)	Water Surface Elevations (ft)	
					Sta D0+00	Sta D1+46
0-35	--	all	--	--	--	--
229	2	69	--	160	5412.90	5412.16
446	5	86	--	360	5414.39	5413.86
647	10	97	--	550	5415.54	5415.03
790	20	103	27	660	5416.16	5415.60
1045	50	110	135	800	5416.93	5416.28

Hec-Ras output for ditch model; Output used for determination of flow apportionment at 2, 5, 10, 20, and 50 yr Silver Bow Creek discharges.

Ditch Station	Hec-Ras Station	Q (cfs)	W.S. Elev (ft)	Q (cfs)	W.S. Elev (ft)	Q (cfs)	W.S. Elev (ft)	Q (cfs)	W.S. Elev (ft)	Q (cfs)	W.S. Elev (ft)
D0+00	959	160	5412.90	360	5414.39	550	5415.54	687	5416.15	935	5416.93
D0+32	958	160	5412.61	360	5414.20	550	5415.38	687	5415.99	935	5416.74
D1+00	957.9	160	5412.33	360	5413.96	550	5415.12	687	5415.68	935	5416.33
D1+46	957.8	160	5412.16	360	5413.86	550	5415.03	674	5415.60	867	5416.28
D1+66	957.5	160	5412.09	360	5413.81	550	5414.99	660	5415.58	800	5416.28
D1+72	955.5	160	5412.08	360	5413.82	550	5415.00	660	5415.59	800	5416.31
D1+84	955.4	160	5411.91	360	5413.52	550	5414.63	660	5415.20	800	5415.89
D2+32	955.3	160	5411.67	360	5413.30	550	5414.42	660	5415.00	800	5415.70
D3+00	955.2	160	5411.43	360	5413.08	550	5414.22	660	5414.80	800	5415.53

SSTOU, Subarea 1, Reach A design

D. White, 4/6/98

Headwater elevation vs. discharge for culverts*

*two 30" diameter CMP culverts

Discharge (cfs)	Headwater WSEL (ft) (at ditch Sta. 0+00)
10	5409.79
15	5410.09
20	5410.34
25	5410.57
30	5410.79
35	5411.01
40	5411.22
45	5411.43
50	5411.65
55	5411.89
60	5412.18
65	5412.58
70	5412.98
75	5413.4
80	5413.84
85	5414.29
90	5414.78
95	5415.28
100	5415.79
105	5416.35
110	5416.96
115	5417.54
120	5418.2
125	5418.91
130	5419.64
135	5420.09
140	5420.19
145	5420.27
150	5420.36
155	5420.42

Hec-Ras output for two 30"culverts at 110 cfs

Parameter	
Culv Q (cfs)	110
# Barrels	2
Q Barrel (cfs)	55
Culvert length (ft)	107
W.S. US. (ft)	5416.96
E.G. US. (ft)	5416.97
Delta WS (ft)	7.14
Delta EG (ft)	6.99
E.G. IC (ft)	5416.89
E.G. OC (ft)	5416.97
Culv WS In (ft)	5411.1
Culv WS Out (ft)	5410.7
Culv Nml Depth (ft)	2.5
Culv Crt Depth (ft)	2.5
Culv Vel In (ft/s)	11.2
Culv Vel Out (ft/s)	**11.2**
Culv Inv El Up (ft)	5408.6
Culv Inv El Dn (ft)	5408.2
Culv Frctn Ls (ft)	2.56
Culv Ext Lss (ft)	2.68
Culv Ent Lss (ft)	1.75

SSTOU, Subarea 1, Reach A design

D. White, 4/6/98

Spillway discharge based on upstream water surface

Weir discharge (cfs)	Water surface at Sta. D1+46 (ft)
5	5415.29
10	5415.39
15	5415.46
20	5415.53
25	5415.58
30	5415.63
35	5415.67
40	5415.72
45	5415.76
50	5415.8
55	5415.83
60	5415.87
110	5416.16
115	5416.18
120	5416.21
125	5416.23
130	5416.26
135	5416.28

Calculation of superelevation of water surface at diversion structure

Superelevation (D) = (V^2*T)/(gR)*

Where: V = mean velocity
T = channel surface width
g = gravitational constant
R = bend radius of curvature

From Hec-Ras output and plan map:
V = 6 (from reconstructed channel model @ 1042 cfs)
T = 40 ft
g = 32.2 ft/sec^2
R = 120 ft

D = 36(40)/32.2(120) = 0.4 ft

* from Design of Roadside Channels with Flexible Linings, FHWA Hec 15

SSTOU, Subarea 1, Reach A design
D. White, 4/6/98

Weir model output for expected spillway discharge under 20-yr and 50-yr Silver Bow Creek discharges.

Weir model station	Description	Q (cfs)	W.S. Elev (ft)	E.G. Slope (ft/ft)	Velocity (ft/s)	Flow Area (sq ft)	Top Width (ft)	Shear (lb/sq ft)	Wetted Perim. (ft)	Depth (ft)	Froude #
146	Ditch station D1+46	27 (20-yr)	5415.6	0.000012	0.28	96.25	33.74	0	35.62	5.7	0.03
146		135 (50-yr)	5416.28	0.000159	1.12	120.44	37.75	0.03	39.85	6.38	0.11
135	Spillway crest (upstream)	27	5415.59	0.006944	0.81	33.42	63.25	0.23	63.43	0.59	0.2
135		135	5416.23	0.012647	1.8	75.18	67.1	0.88	67.48	1.23	0.3
122	Spillway crest (downstream)	27	5415.23	0.253241	2.41	11.2	61.11	2.89	61.17	0.23	0.99
122		135	5415.59	0.177853	4.07	33.18	63.23	5.81	63.4	0.59	0.99
118.333*	Spillway slope	27	5414.18	0.342019	2.67	10.13	64.28	3.36	64.33	0.16	1.18
118.333*		135	5414.41	0.436433	5.41	24.94	65.65	10.33	65.78	0.39	1.55
114.666*	Spillway slope	27	5412.96	0.304254	2.61	10.36	67.6	2.91	67.65	0.15	1.17
114.666*		135	5413.23	0.273776	4.76	28.36	69.17	6.99	69.31	0.42	1.31
111.*	Spillway slope	27	5411.75	0.331711	2.72	9.94	70.85	2.9	70.89	0.14	1.28
111.*		135	5411.96	0.386422	5.37	25.12	72.12	8.39	72.24	0.35	1.6
107.333*	Spillway slope	27	5410.55	0.252897	2.55	10.59	74.19	2.25	74.24	0.14	1.19
107.333*		135	5410.76	0.316394	5.16	26.19	75.44	6.85	75.56	0.35	1.54
103.666*	Spillway slope	27	5409.32	0.405821	3	8.99	77.37	2.94	77.41	0.12	1.55
103.666*		135	5409.53	0.301961	5.2	25.98	78.68	6.22	78.79	0.33	1.59
100	Base of spillway slope	27	5408.47	0.003044	0.7	38.48	82.84	0.09	82.99	0.47	0.18
100		135	5409.22	0.003188	1.32	101.91	87.31	0.23	87.7	1.22	0.22
88	12 ft downstream of base of spillway	27	5408.44	0.002951	0.7	38.85	82.86	0.09	83.02	0.48	0.18
88		135	5409.18	0.003171	1.32	102.08	87.32	0.23	87.72	1.22	0.22
0	100 ft downstream of base of spillway	27	5408.15	0.003505	0.73	36.87	82.72	0.1	82.87	0.45	0.19
0		135	5408.88	0.003503	1.36	98.98	87.11	0.25	87.49	1.18	0.23

SSTOU, Subarea 1, Reach A Design

D. White, 4/6/98

Gabion Design (based on USDOT FHWA HEC-11)

Criteria for gabion thickness

Bank soil type	Maximum velocity (fps)	Bank slope	Minimum mattress thickness (ft)
Silts, fine sands	10	< 1:2	1* (>1 at toe of slope)

1) Culvert outlet: Maximum expected velocity at 50-yr flood: 11.2 fps
Use 1.5 ft thick gabion over filter fabric

2) Culvert inlet: Maximum expected velocity at 50-yr flood: 11.2 fps
However, no "jet" scour expected as at culvert outlets
Use 1 ft thick gabion over filter fabric

3) Spillway surface: Maximum expected velocity: assume 8-10 fps
based on average velocity of 5.4 fps.
Use 1 ft thick gabion over filter fabric

4) Toe of spillway slope: Use 1.5 ft thick gabion over filter fabric
based on HEC-11 guidelines for toe of slope

5) Stone size: D(30) should be larger than the wire mesh opening (typically 3.25 inches). And smaller than the mattresss thickness.
Use Type 1 Stone

Silver Bow Creek, SSTOU, Subarea 1, Reach A Design
D. White 4/8/98

Slope stability analysis of diversion embankment (berm)

Slope stability analysis based on method presented in *Landslide Investigation and Mitigation: Special Report No. 247.* Transportation Research Board, National Research Council, 1996. Published by National Academy Press. 673 p.

The attached materials describe the methodology and give equations and reference figures.

Assume: Silty sand (SM) berm material (cohesionless soil)
Unit weight = 125 lb/cu ft
Phi = 30 degrees
c is equal to 0 (cohesionless soil)

Driving Force, Pd Equation 13.11

Unit Weight, γ	125	
Slope Height, H	9.1	
Surcharge Pressure, q	0	
Unit Weight of Water, γw	62.4	
Depth of Water Outside Slope, Hw	0	
Depth of Water Inside Slope, Hw'	5	
Surchare Correction Factor, uq	1	Figure 13-4
Water Pressure Correction Factor, uw	1	Figure 13-4
Seepage Correction Factor, uw'	1	Figure 13-4
Tension Crack Correction Factor, ut	1	Figure 13-4
Slope Ratio, b	4	
Friction Angle, phi	30	deg = 0.523333 rad
Cohesion, c	0	

Pd = 1137.5
Pe = 825.5

Factor of safety

For cohesionless soils: FS = Pe/Pd * b * tan(phi)

b = 4, phi = 30

FS =	1.7

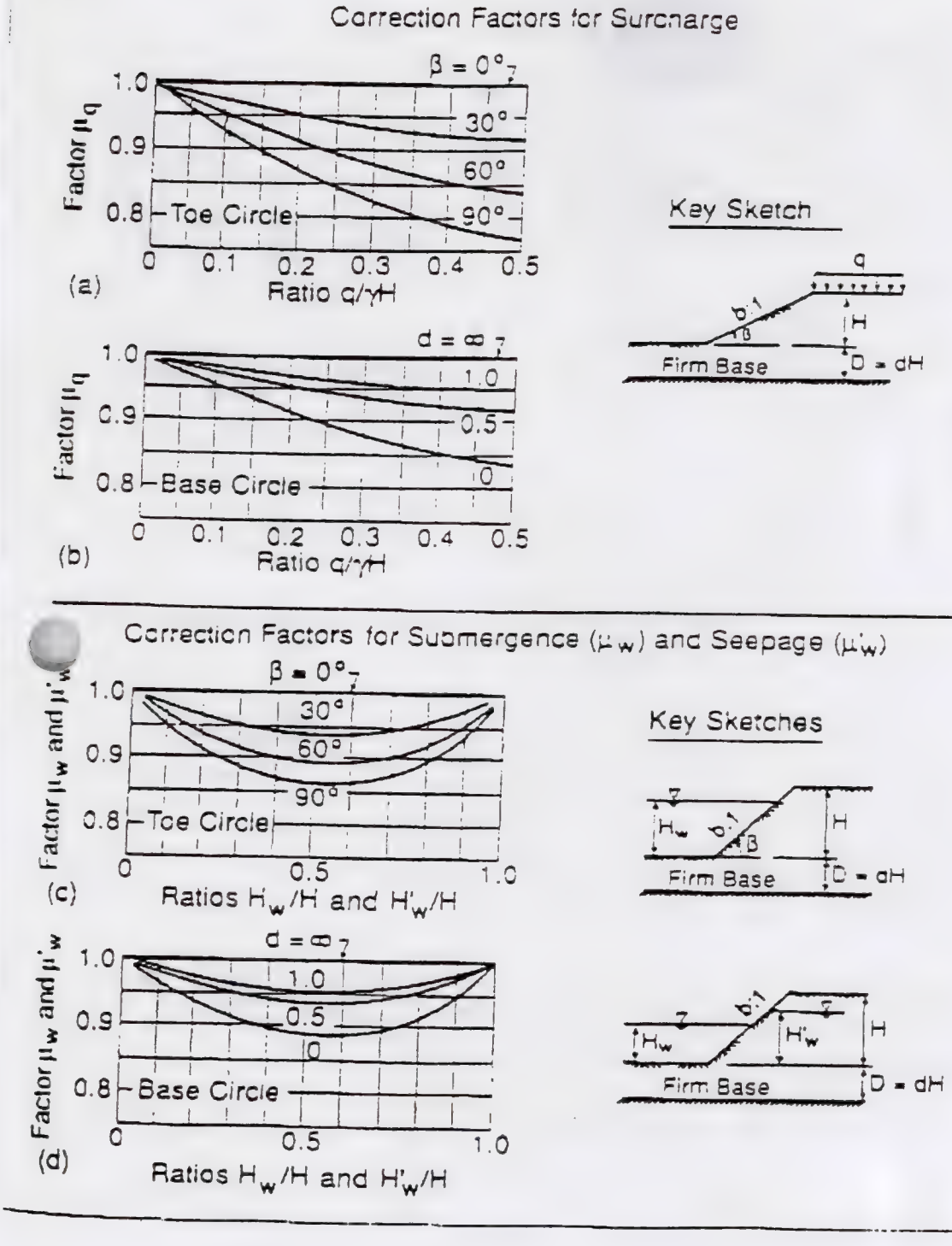


FIGURE 13-4
Correction factors for slope stability charts for $\phi = 0$ and $\phi > 0$ soils for cases with surcharge, submergence, or seepage (modified from Jancu 1968)

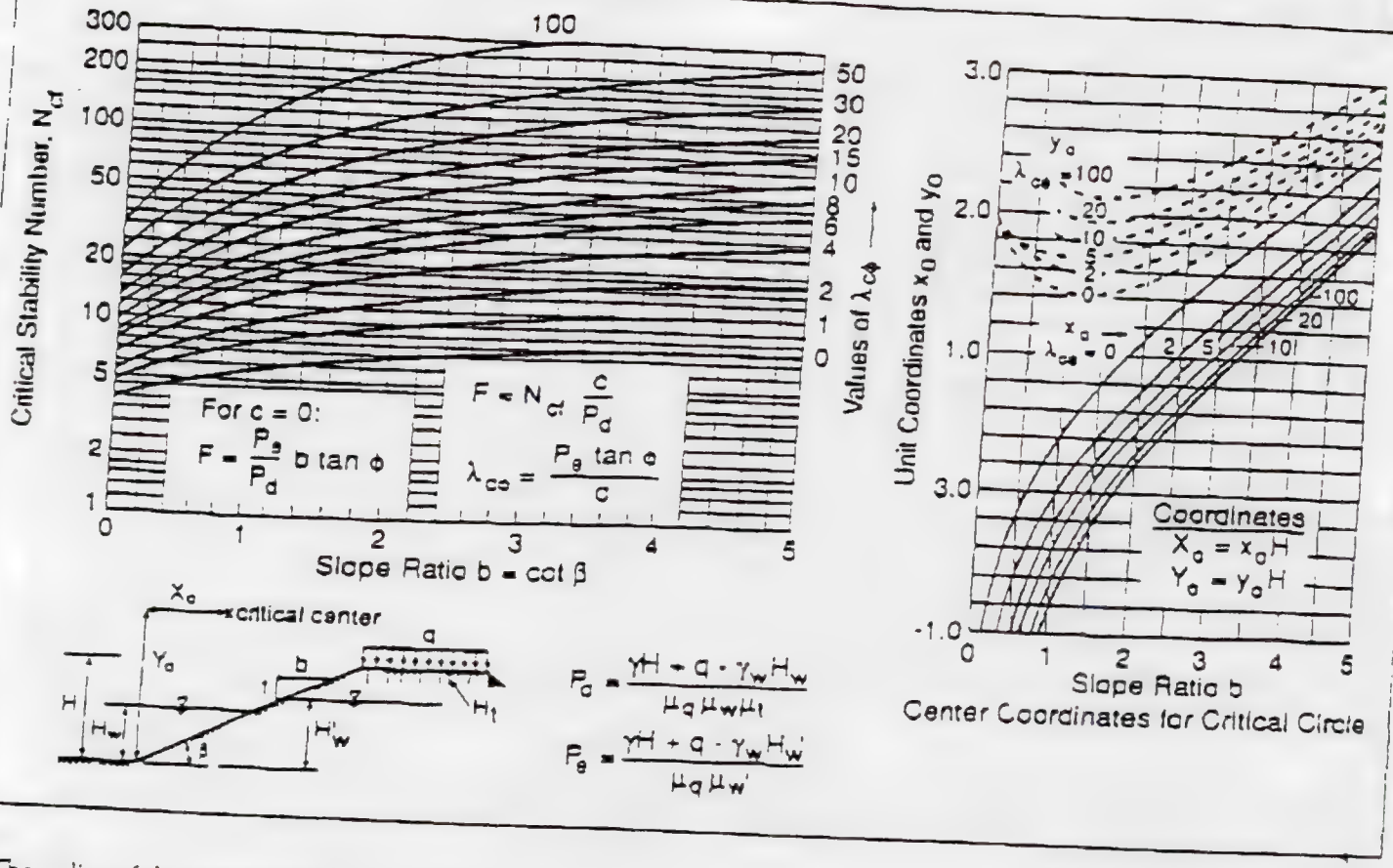

Critical Stability Number, N_{cf}
Slope Ratio b = cot β
For c = 0:
$F = \frac{P_a}{P_d} b \tan \phi$
$F = N_{cf} \frac{c}{P_d}$
$\lambda_{c\phi} = \frac{P_a \tan \phi}{c}$
Values of $\lambda_{c\phi}$
critical center
$P_a = \frac{\gamma H + q - \gamma_w H_w}{\mu_q \mu_w \mu_t}$
$P_a = \frac{\gamma H + q - \gamma_w H_w'}{\mu_q \mu_w'}$
Unit Coordinates x_o and y_o
Coordinates
$X_o = x_o H$
$Y_o = y_o H$
Slope Ratio b
Center Coordinates for Critical Circle

FIGURE 13-6
Slope stability charts for $\phi > 0$ soils (modified from Janbu 1968).

The radius of the critical circle is determined by the position of the center of the circle and the fact that the circle is tangent to a horizontal plane at depth D below the bottom of the slope. Using the chart in Figure 13-3, it is possible to calculate factors of safety for a range of depths (D) to determine which is most critical. If the value of S_u in the foundation does not vary with depth, the critical circle will extend as deep as possible, and only a circle extending through the full depth of the clay layer need be analyzed. If the strength of the foundation clay increases with depth, the critical circle may or may not extend to the base of the layer, and it is necessary to examine various depths to determine which is most critical.

The upper part of Figure 13-3 gives values of the stability number, N_o, which is related to the factor of safety by the expression

$$F = N_o \frac{c}{P_d} \qquad (13.10)$$

where

F = factor of safety (dimensionless),
N_o = stability number from Figure 13-3 (dimensionless), and
$c = S_u$ = undrained shear strength (in stress units).

The value of P_d is given by the expression

$$P_d = \frac{\gamma H + q - \gamma_w H_w}{\mu_q \mu_w \mu_t} \qquad (13.11)$$

where

P_d = driving force term (in pressure units),
γ = unit weight (force per length cubed),
H = slope height (length),
q = surcharge pressure on top of slope (in stress units),
γ_w = unit weight of water (force per length cubed),
H_w = depth of water outside slope, measured above toe (length),
μ_q = surcharge correction factor,
μ_w = water pressure correction factor, and
μ_t = tension crack correction factor

The correction factors μ_1, μ_w, μ_i are given in Figures 13-4 and 13-5.

5.3 Soils with $\phi > 0$

In most cases for slopes in soils with $\phi > 0$, the critical slip circle passes through the toe of the slope. The stability chart shown in Figure 13-6 is based on the assumption that this is true. The coordinates of the center of the critical toe circle are shown in the chart on the right side of Figure 13-6.

Cohesion values, friction angles, and unit weights are averaged using the procedures described at the beginning of this chapter. The factor of safety is calculated using the expression

$$F = N_d \frac{c}{P_z} \qquad (13.12)$$

where N_d is the stability coefficient from the chart on the left-hand side of Figure 13-6 (dimensionless), c is the average cohesion intercept (in stress units), and P_z is defined by Equation 13.11.

The values of N_d shown in Figure 13-6 are determined by the value of b = cotangent of the slope angle = cot β and the value of the dimensionless parameter, $\lambda_{c\phi}$. The latter is calculated using the expression

$$\lambda_{c\phi} = \frac{P_z \tan\phi}{c} \qquad (13.13)$$

where c and $\tan\phi$ are the average values of cohesion intercept and friction angle. The value of P_z is defined as

$$P_z = \frac{\gamma H + q - \gamma_w H_w'}{\mu_1 \mu_w'} \qquad (13.14)$$

where H_w' is the effective average water level inside the slope measured above the toe of the slope (in length units), μ_w' is the seepage correction factor from the lower part of Figure 13-4, and γ, H, q, and μ_1 are as defined previously.

The value of H_w', somewhat difficult to estimate using judgment, is related to H_c, the water level measured below the crest of the slope, as shown in Figure 13-7. When the value of H_c has been determined by field measurements or seepage analyses, the value of H_w' can be determined using the curve given in Figure 13-7.

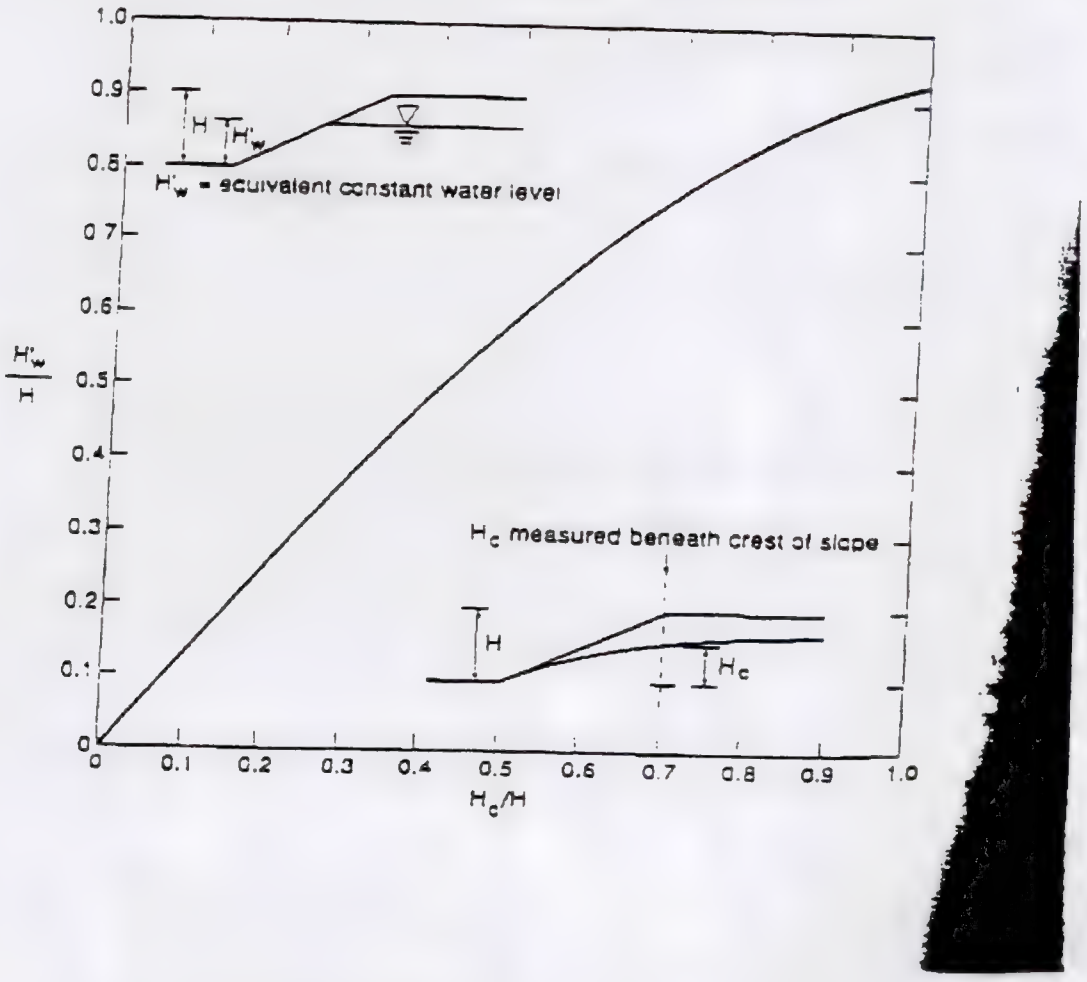


FIGURE 13-7
Chart for determining steady seepage conditions (modified from Duncan et al. 1987).

Silver Bow Creek, SSTOU, Subarea 1, Reach A Design

D. White 4/8/96

Dam Sliding Stability Analysis

Assumptions:

- triangular cross-section dam
- gravity dam with negligible resistance at abutments
- high permeability substrate
- low permeability dam material (bouyancy disregarded)
- forces act on centroid of dam (moments are disregarded)
- negligible slope

Given:				
Height of dam =	9.1 ft			
Slope of front face =	2 H:1V	=	0.463648 rad =	26.56505 deg
Slope of back face =	4 H:1V	=	0.244979 rad =	14.03624 deg
Dry unit weight of dam material =	110 lbs/cf			
Wet unit weight of dam material =	125 lbs/cf			
Width of slice of dam =	1 ft		(unit width of 1 ft)	
Cohesion of dam material, C =	0 lbs/sf			
Angle of internal friction of dam material, phi =	30 degrees	=	0.523599 rad	
Impounded water surface height, h1 =	9.1 ft			
Water surface height below dam, h2 =	2 ft			

profile length of dam = 58 ft
cross-sectional area of dam profile = 281 sf

Weight of slice of dam

W = 34919.5 lbs
Normal stress under dam = 602.06 lbs/sf

Hydrostatic Forces	Front (Impound)	Back
Wetted length of dam face =	20.35 ft	8.25 ft
Wetted area of dam face =	20.35 sf	8.25 sf
Ave pressure acting on dam face =	283.92 lbs/sf	62.40 lbs/sf
Force acting on dam face =	5777.27 lbs	514.56 lbs
Horizontal component of force =	2583.67 lbs	124.80 lbs
Vertical component of force =	5167.34 lbs	499.20 lbs

Ave Hydrostatic pressure = 1/2(gamma)h

Hydrostatic Uplift Pressure Distribution

Pu = 364.98 lbs/sf

Driving Stress, D

D = horizontal forces acting on dam / area of base of dam = 42.39 lbs/sf

Resisting Stress, R

R = C + (P)[tan(phi)]

function of Coulomb's theory of strength of materials

Effective normal stress, P = (weight of dam) + (vertical component of hydrostatic force) - (hydrostatic uplift pressure) / area of dam base

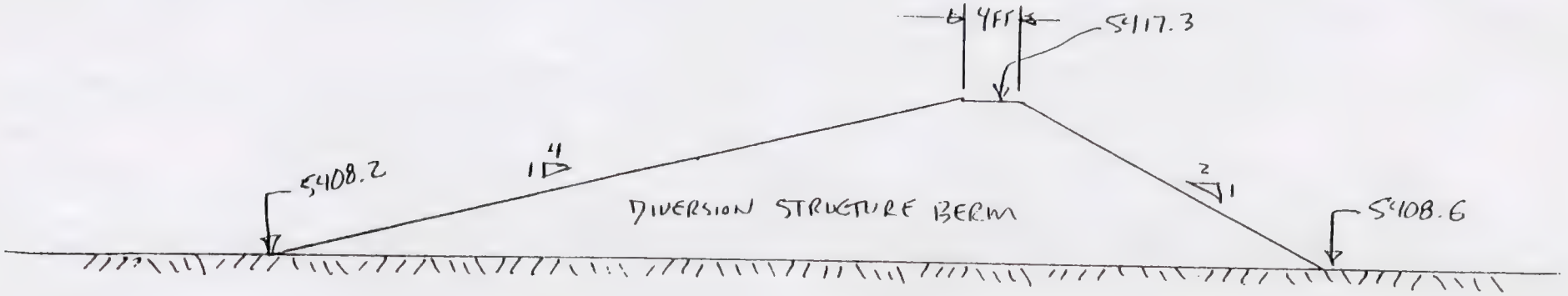
P = 334.78 lbs/sf

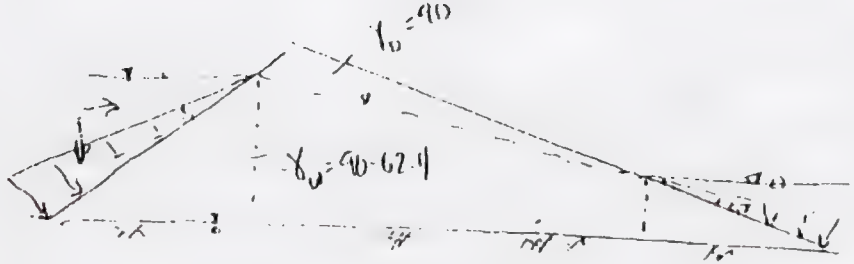
R = 193.29

Factor of Safety

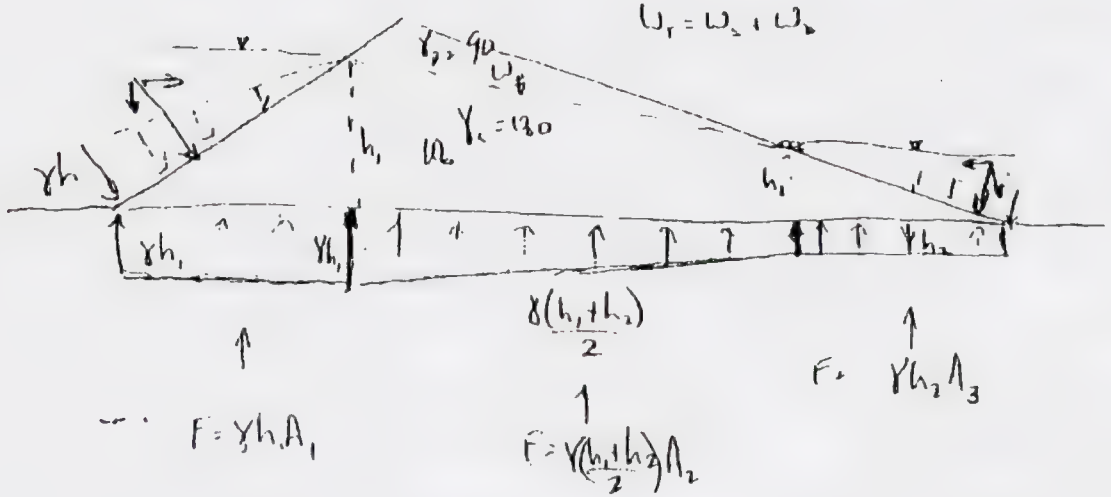
F.S. = Resisting Stress = R/D = 4.56
Driving Stress

AMPAD 22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS





CASE
HIGH PERM DAM
HIGH PERM BASE



★ CASE
LOW PERM DAM
HIGH PERM BASE

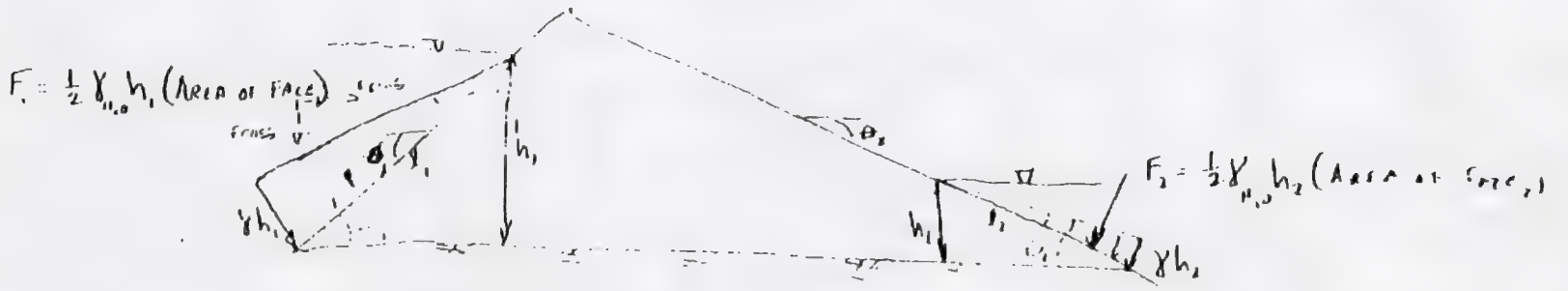
WEIGHT OF WATER: $W_w = \gamma_w V_w = \gamma_w B \Sigma A_w = \gamma_w (A_1 + A_2 + A_3)(1)$

$= \gamma_w \left[\frac{1}{2} h_1 m_1 h_1 + \frac{1}{2} h_2 m_2 h_2 + \frac{1}{2}(h_1 + h_2)(L_T - m_1 h_1 - m_2 h_2) \right](1)$

WEIGHT OF DRY MATERIAL: $W_D = \gamma_D V_D = \gamma_D B (A_T - (A_1 + A_2 + A_3))(1)$

TOTAL WEIGHT OF BEAM: $W_T = W_w + W_D$

B. WIDTH OF SLICE = 1 FT



$$\sin\theta = \frac{h_1}{l_1}$$

$$l_1 = h_1 / \sin\theta$$

AREA OF FACE $= l_1 B$

$$F_1 = \frac{1}{2}\gamma h_1 l_1 B$$

HORIZONTAL COMPONENT: $F_{1H} = F\sin\theta$

$$= \frac{1}{2}\gamma h_1 l_1 \sin\theta_1$$

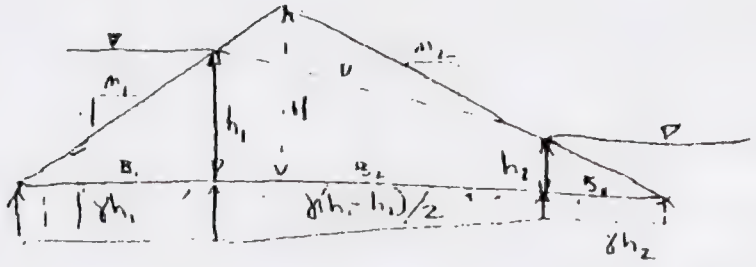
VERTICAL COMPONENT $F_{1V} = \frac{1}{2}\gamma h_1 l_1 \cos\theta_1$

$$F_{2H} = -\frac{1}{2}\gamma h_2 l_2 \sin\theta_2$$

$$F_{2V} = -\frac{1}{2}\gamma h_2 l_2 \cos\theta_2$$

$$= \frac{\gamma h_1 A_1 + \gamma\left(\frac{h_1+h_2}{2}\right)A_2 + \gamma h_2 A_3}{A_T}$$

X = WIDTH INTO SECTION = 1 FT



$A_1 = B_1 X$

$B_1 = m_1 h_1$

$A_1 = m_1 h_1 X$

$A_3 = m_2 h_2 X$

$A_2 = A_T - (A_1 + A_3)$

$A_T = (1/m_1 + 1/m_2)X$

$A_2 = (1/m_1 + 1/m_2)X - (A_1 + A_3)$

$$P = \frac{\gamma\left[\left(h_1 m_1 h_1\right) + \left(\left(\frac{h_1+h_2}{2}\right)\left(\left(1/m_1 + 1/m_2\right) - \left(m_1 h_1 + m_2 h_2\right)\right)\right) + \left(h_2\left(m_2 h_2\right)\right)\right] X}{\left(1/m_1 + 1/m_2\right) X}$$

$$P = \frac{\gamma\left[\left(h_1^2 m_1\right) + \left(\left(\frac{h_1+h_2}{2}\right)\left(\left(H(m_1+m_2)\right) - \left(m_1 h_1 + m_2 h_2\right)\right)\right) + \left(h_2^2 m_2\right)\right]}{H(m_1+m_2)}$$

DRIVING STRESS, D

$$D = \frac{\text{HORIZONTAL FORCES ACTING ON DAM}}{\text{AREA OF BASE OF DAM}}$$

$$= \frac{\Sigma F_H}{L_T B}$$

$$= \frac{F_{H_1} - F_{H_2}}{L_T}$$

$$= \frac{\frac{1}{2}\gamma(h_1 l_1 \sin\theta_1 - h_2 l_2 \sin\theta_2)}{L_T}$$

RESISTING STRESS, R

$$R = C + P_n \tan\phi$$

WHERE: C = COHESION OF DAM MATERIAL, lb/ft²

ϕ = ANGLE OF FRICTION

P_n = EFFECTIVE NORMAL STRESS, lb/ft²

$$= \frac{W}{A_B} + \frac{\Sigma F_V}{A_B} - \text{UPLIFT PRESSURE}$$

WHERE:

W = WEIGHT OF DAM

A_B = AREA OF BASE OF DAM

F_{V_1} = SUM OF VERTICAL COMPONENTS OF HYDROSTATIC FORCES

FACTOR OF SAFETY FOR SLIDING STABILITY

$$F.S. = \frac{\text{RESISTING STRESS}}{\text{DRIVING STRESS}} = \frac{R}{D}$$

APPENDIX C-2

Diversion Channel

Memorandum

To: SSTOU, Subarea 1, Reach A Design
From: Dale White
Date: April 7, 1998
Regarding: Diversion embankment and channel lining.

The diversion channel embankments (berms) will be constructed of fill material, placed and compacted as per the Specifications, with side slopes of 2(H):1(V) and a top width of 4 ft. An analysis of the structural stability of the proposed embankment is attached.

The diversion channel lining will consist of a layer of stone riprap placed 1 ft thick. The lining will extend to 1 ft above the 610 cfs water surface as determined by Hec-Ras modeling, with the exception of two short reaches discussed below. The top of the channel berms will coincide with the 800 cfs water surface elevation. A flow of 800 cfs is the expected diversion channel discharge during the 50-yr event.

Exceptions to the above-mentioned criteria are: 1) the outside of the sharp bend from station D2+00 to D3+00, where an additional 0.5 ft (for a total of 1.5 ft) must be added to account for the calculated superelevation of the water surface; and 2) the diversion structure berm, where an additional 0.4 ft was added for the same reason (see attached sheets for superelevation calculations). At both of these locations, riprap will be installed to the top of the berm.

There will be no filter installed below the riprap due to the short expected duration of flows and the limited (5-10 yr) lifespan of the diversion channel. An exception is the riprap basin immediately below the large pipe-arch culvert at the county road crossing. Since this basin is to remain after the rest of the ditch is retired (in 5-10 yr), granular filter will be installed under the riprap in this location.

The following two size gradations of diversion channel lining are specified.

Size Gradation	% Finer by Weight			
	100%	70-90%	40-60%	5-20%
Type 1 Stone	10"	8"	7"	4"
Type 2 Stone	7"	5"	4"	2"

These gradations were based on calculation of incipient motion size based on Hec-Ras output. Within the diversion channel, high and low energy reaches were defined based on shear values. The high energy reaches included segments D1+80 - D3+00 (at the sharp bend) and the channel lying downstream of the county road crossing. Within these segments, the highest shears occurred at stations D2+36, D46+92, and D51+92. Calculations (see attached) yielded incipient motion sizes of 6.6, 6.2, and 6.7 inches, respectively, for these cross-sections. Based on this analysis, a D_{50} particle size of 7 inches was chosen for the high energy reaches. This corresponds to Type 1 Stone.

The low energy reaches included all channel upstream of the county road crossing with the exception of stations D1+80 - D3+00, which lie on a sharp bend. The two highest energy cross-sections within the low energy reach were D3+75 and D21+92, which had incipient motion particle sizes of 3.8 and 3.7 inches, respectively. Based on these results, a D_{50} particle size of 4 inches was chosen for this reach. This corresponds to Type 2 Stone.

Feb 13, 1998

SILVER BOW CR

DIVERSION DITCH

DESIGN OF EMBANKMENT

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

SUMMARY

Should check mechanical stability, safety against seepage, and piping

For ditch embankment, because it is less than 4 m (7.5' < 13'), and because soils are sandy loam (generalization from bore logs), can construct homogenous structure from local soil (more clay would be better).

SEEPAGE

Does not require seepage investigation because low levee and seepage requires a long period of time to establish seepage line. Hydrograph for 100 year should not be that long.

Calculated seepage of 1.1×10^{-5} ft³/s to 7.3×10^{-5} ft³/sec for 39 ft base - seems small and ok ✓.

MECHANICAL

Mechanically stability is dependent mainly on side slopes.

SIDE SLOPES

Can go with a 1:2 riprapped river-side slope

(riprap min. 1:1½, "summer" levee min 1:2 COE says 1:3)

Would use flatter slope if no riprap.

Land side slope - 1:2.5 (Conflicting info in books - some have land side slope greater than river - others less) (1:2 to 1:2.5 or 1:4)

TOP

Usually set by width for access. We don't need access and looks like we get enough width from side slopes.

For weather to allow good erosion and ↑ Compaction near top ≈ 4 ft Width suggested.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

DRAWDOWN

BECAUSE soils - sandy loam, silty loam, loamy sand, have fairly good permeability (pervious to semi-pervious), this should not be a problem.

PORE PRESSURE - PIPING

The calculations based on critical hydraulic gradient show that this is not a problem at all ($i = .16 < < < 1.0 = i_c$). Calculations based on effective pressure and the weight of a soil grain indicate that large grain sizes (coarse sand instead of existing fine to medium sands) are needed to prevent piping. Suggested protection would be an apron of small gravel at the toe of the levee on the landside. However, the gravel does not appear necessary at this time because 1. Life of levee is short (5 to 10 yrs),

2. Periods of high flows are short, and
3. Not a huge difference in grain sizes, 1.3 mm would be good versus ~ 0.9 mm.

FEB 13, 1998

SILVERBOW CR

DITCH LEVEE DESIGN

What are the dimensions of the ditch walls - what is the size of the levee required?

Concerned with: 1. Pore pressures
2. Stability structure
3. Drawdown stability

Because of small size of wall, the major concern is probably pore pressure resulting from seepage.

a) Levees are longitudinal dams and "must satisfy the same structural criteria as regular dams".

"Material should be placed in layers and compacted, with the least pervious material along the riverside of the levee."

"most levees are homogeneous embankments

", an adequate berm is left between the toe of the levee and the ditch to avoid collapse of the ditch bank,"

"Top width of levees is usually determined by the use to which they are to be put, with a minimum width of about 10 ft to permit movement of maintenance equipment."

a. Water Resources Eng. Linsley & Franzini 1979

"Homogeneous profile may be made of silt, silty sand (loam) or sandy clay. A portion of sand in such a soil mixture is desirable at all times".

Levees of low or medium height (4-5 m) are mostly made as homogeneous constructed from local, found soils.

"Seepage is a very slow process and the establishment of a seepage line requires a long period of time. Because levees are rarely exposed to high water levels, and for relatively short periods only, the danger from seepage is much more limited than for dams. Thus low and med levees under ordinary conditions do not require special investigations of the seepage condition".

"Piping can be a danger for levee's which are built on permeable subsoil.

"Design of levee should be such as to ensure its mechanical stability and safety against failure from seepage or piping."

"Mechanical stability is largely dependent on the side slopes of the levee's... For levees that do not exceed height of 4 m, and have no particular foundation problems, the recommended river-side slope is 1:3 or 1:3.5 and the land side slope is 1:2 or 1:2.5. Sand and heavy clay are generally considered unsuitable soil materials, ..." Clayey or silty gravel shown in figure.

In general, it is in the range of 2.5 to 5 m with about 3 m probably most frequent choice".

"When borrow pits are necessary, they should not be located in the vicinity of the levee, whether they are river-side or on the landside," They favor piping. "Suitable distance should be about 5 to 10 times the height of the levee.

Freeboard with dikes 0.6 to 1.5 m.

Summer levees - river slope 1:2 to 1:3
land slope 1:4

River Training Techniques Przedwoj. ' — — 1995

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

"Upstream slope may vary from 2:1 to as flat as 4:1 for stability"

"Flat upstream slopes are sometimes used to eliminate expensive slope protection".

"A storage dam subject to rapid drawdown of the reservoir should have an upstream zone with permeability sufficient to dissipate pore water pressures excited outwardly in the upstream part of the dam." If clays - provide a flat slope for rapid drawdown.

"Usual downstream slope for small earthfill dams are 2:1 where a downstream pervious zone is provided in the embankment and 2.5:1 where the embankment is impervious. These slopes are stable for soil types commonly used when drainage is provided in the design, so that the downstream slope of the embankment does not become saturated by seepage

$$K = 6.5 \times 10^{-5}\ ft/sec \times \frac{12\ in}{1\ ft} \times \frac{2.54\ cm}{1\ in} = 2.0 \times 10^{-3}$$

Bore logs most frequent description as sandy loam silty loam loamy sand - some clays

From Fig 5-12 = SM - Sands w/ fines

K is given as (from Maxon Pilot) 2.6×10^{-3} From Fig 5-14 makes it a very pervious SM - or a borderline Pervious to semi pervious material

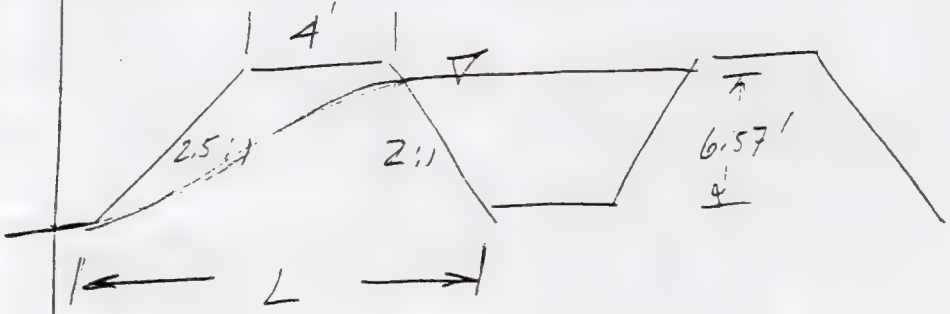
* This makes drawdown not a problem because the material should drain alright. But important to check pore pressures

Effective Stress from FOUNDATION ENG. Peck, Hanson & Thornburn 1974

The increase in effective pressure due to the flow of water through the voids is known as seepage pressure. It is the result of the frictional drag of the flowing water on the soil grains.

$\bar{p}$ = effective pressure = $\Sigma \gamma' + i' \Sigma \gamma_w$

"The hydraulic gradient (i) at which the effective pressure becomes zero is known as the "critical hydraulic gradient i_c. Under these conditions a cohesionless soil cannot support any weight on its surface."



6.57 + 1' Freeboard = 7.57' × 2

7.57 × 2 = 15.14

7.57 × 2.5 = 18.93

34.07 + 4' = 38' = L

$i = h/L = \frac{6.57}{38} = 0.17$

$i_c = \frac{\gamma'}{\gamma_w}$ ($\gamma_{sat} - \gamma_w$ = submerged unit wt.) = (gm/cc wet - water)

Saturated Dense Mixed grain Sand w fully sat. = 16%

γ_d = 116 (Table 2.3 Perloff & Baron)

1.16 × 116 = 135 lb/ft³ fully sat γ_s SM max unit wt = 132.5 lb/ft³ (Design Small Dams)

$$i_c = \frac{\gamma'}{\gamma_w} = \frac{\gamma_{sat} - \gamma_w}{\gamma_w} = \frac{135 - 62.4}{62.4} = \frac{72.6}{62.4} = 1.16$$

Since $1.16 >> 0.17$ seems OK ✓

$\bar{P} = z\gamma' + j z \gamma_w$ z = distance through material = 39'

$= 6.57(72.6) + \frac{6.57}{39}(6.57)(62.4) = 548 - 16 = 532 \text{ lb/ft}^2$ = effective press

$= 3.8$ psi

Particle of Sand ~ .09 mm = .009 cm × $\frac{1 \text{ in}}{2.54 \text{ cm}}$ = .0035 in = Dia. ave grain

$3.8 \frac{\text{lbs}}{\text{in}^2} \times .00001 \text{ in}^2 = .000038 \text{ lbs}$ $A = \pi r^2 = .00001$

$3.8 \times 10^{-5} = \text{lbs}$

Wt. grain = $\left(\frac{.0035}{2}\right)^3 \pi \frac{3}{4} \times \frac{1 \text{ ft}^3}{1728 \text{ in}^3} = 7.3 \times 10^{-12} \text{ ft}^3$

$3/4 \pi r^3$

Dry $\gamma = 116 \text{ lbs/ft}^3 \times 7.3 \times 10^{-12} \text{ ft}^3 = 8.5 \times 10^{-10} \text{ lbs}$

Effective Pressure = 3.8×10^{-5} lbs

Wt. grain = 8.5×10^{-10} lbs Seems like possible blow out

Larger grain?

$3.8 \times 10^{-5} \text{ lb} \times \frac{1 \text{ ft}^3}{116 \text{ lbs}} = 3.28 \times 10^{-7} \text{ ft}^3 = 4/3 \pi r^3$

$r = 0.004$ ft

$= .0516$ inch

$= 1.3$ mm

Course Sand can withstand seepage,

Also assuming cohesionless material?

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

PERMEABILITY :

Maximum measured (or selected for pilot reach?) 35 gal/day/ft^2 = 6.5×10^{-5} ft/sec

$$v = -K \frac{dh}{ds} = -6.5 \times 10^{-5} \text{ ft/sec} \left(\frac{6.57 \text{ ft}}{38 \text{ ft}} \right) = \frac{.000011 \text{ ft}^3/\text{sec}}{(\text{ft} \cdot \text{ft}^2)}$$

$\times$ 6.5 ft = .000073 ft^3

$\times$ 2500 ft = 0.18 cfs Seems very low,

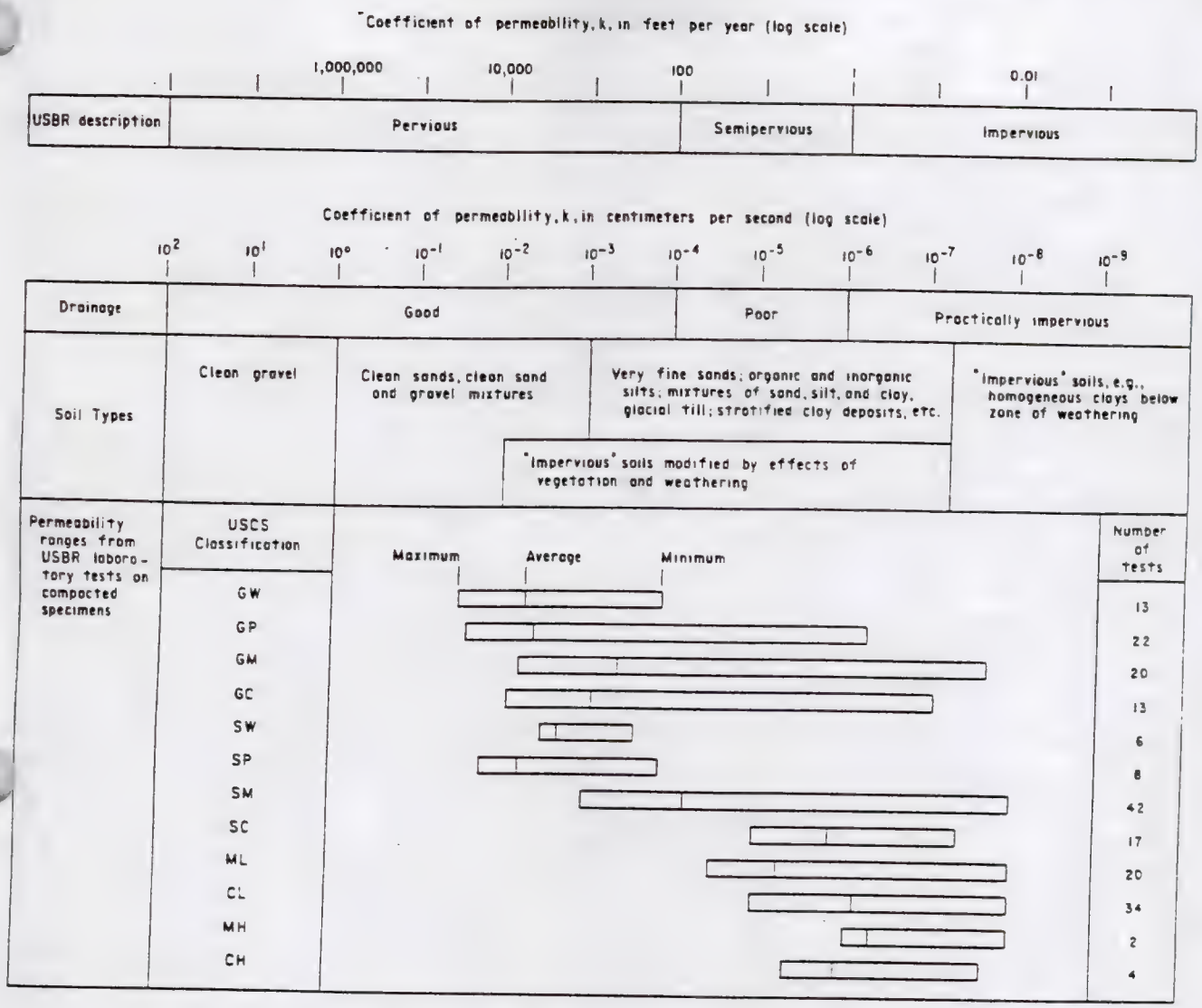


Figure 5-14.—Permeability of soils. (After Casagrande and Fadum, 1940). 103-D-1860.

E. ROCK CLASSIFICATION AND DESCRIPTION OF PHYSICAL PROPERTIES OF ROCK

5.19. *General.*—(a) *Definition and Types.*—Rock is defined as an aggregate of one or more minerals. However, to the engineer the term "rock" usually signifies hard or lithified substances that require mechanical or explosive methods to excavate. Based on their principal mode of origin, rocks are grouped into three large classes: igneous, sedimentary, and metamorphic. These are discussed in more detail in sections 5.20, 5.21, and 5.22, respectively.

(b) *Mineral Identification.*—The physical properties of a mineral, which are controlled by its chemical composition and molecular structure, are valuable aids in its identification and, consequently, in rock identifications. These properties include hardness, cleavage, fracture, luster, color, and streak. Those characteristics that can be determined by simple field tests are introduced to aid in the identification of minerals and indirectly in the identification of rocks.

(1) *Hardness.*—The hardness of a mineral is a measure of its ability to resist abrasion or scratch-

CRITERIA FOR ASSIGNING GROUP SYMBOLS AND GROUP NAMES USING LABORATORY TESTS [a]				SOIL CLASSIFICATION	
				GROUP SYMBOL	GROUP NAME [b]
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVELS More than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS Less than 5% fines [c]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [e]	GW	Well-graded gravel [f]
			$Cu < 4$ and/or $1 > Cc > 3$ [e]	GP	Poorly graded gravel [f]
		GRAVELS WITH FINES More than 12% fines [c]	Fines classify as ML or MH	GM	Silty gravel [f,g,h]
			Fines classify as CL or CH	GC	Clayey gravel [f,g,h]
	SANDS 50% or more of coarse fraction passes No. 4 sieve	CLEAN SANDS Less than 5% fines [d]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [e]	SW	Well-graded sand [i]
			$Cu < 6$ and/or $1 > Cc > 3$ [e]	SP	Poorly graded sand [i]
		SANDS WITH FINES More than 12% fines [d]	Fines classify as ML or MH	SM	Silty sand [g,h,i]
			Fines classify as CL or CH	SC	Clayey sand [g,h,i]
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	SILTS AND CLAYS Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k,l,m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k,l,m]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay [k,l,m,n] Organic silt [k,l,m,o]
	SILTS AND CLAYS Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay [k,l,m]
			PI plots below "A" line	MH	Elastic silt [k,l,m]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay [k,l,m,p] Organic silt [k,l,m,q]
Highly organic soils		Primarily organic matter, dark in color, and organic odor		PT	Peat

a. Based on the material passing the 3-in (75-mm) sieve.
b. If field sample contained cobbles and/or boulders, add "with cobbles and/or boulders" to group name.
c. Gravels with 5 to 12% fines require dual symbols
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
d. Sands with 5 to 12% fines require dual symbols
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
e. $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
f. If soil contains $\geq$ 15% sand, add "with sand" to group name.
g. If fines classify as CL-ML, use dual symbol GC-GM, SC-SM.
h. If fines are organic, add "with organic fines" to group name.
i. If soil contains $\geq$ 15% gravel, add "with gravel" to group name.
j. If the liquid limit and plasticity index plot in hatched area on plasticity chart, soil is a CL-ML, silty clay.
k. If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains $\geq$ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains $\geq$ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
n. PI $\geq$ 4 and plots on or above "A" line.
o. PI $<$ 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.

Figure 5-12.—Soil classification chart (laboratory method). (Sheet 1 of 2).

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Typical values are

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Specific Gravity G
2.72
5.17–5.18
2.64–2.69
2.60–2.68
2.20–2.74
3.00–3.47

TABLE 2.3
Unit Weight, Porosity, and Void Ratio of Typical Soils in Natural State

Description	Unit Weight (pcf) γ_d	Unit Weight (pcf) γ	Porosity n (%)	Void Ratio e	Water Content Fully Saturated w (%)
Uniform sand					
Loose	90	118	46	0.85	32
Dense	109	130	34	0.51	19
Mixed-grained sand					
Loose	99	124	40	0.67	25
Dense	116	135	30	0.43	16
Glacial till, very mixed-grained	132	145	20	0.25	9
Glacial clay					
Soft	—	110	55	1.20	45
Stiff	—	129	37	0.60	22
Soft organic clay					
Slight organic content	—	98	66	1.90	70
High organic content	—	89	75	3.00	110
Soft bentonite	—	80	84	5.20	194

SOURCE: Terzaghi and Peck (1967).

Note that the unit weight provides the only link between the two sides of the phase diagram (G is the ratio of two unit weights). Unit weights are frequently called "densities." This is a misnomer; however, a careful distinction between unit weight and density is necessary only in a few cases.

The phase diagram is generally useful in two kinds of problems. The first type is that in which it is desired to derive a general relationship between certain given or measured quantities and some other quantity of interest. Examples 2.1 and 2.2 illustrate this type of problem.

Example 2.1

The task here is, knowing the void ratio e, to determine the porosity n. To do this, we may imagine that the phase diagram in Figure 2.6 represents an arbitrary, convenient quantity of soil. Suppose that we choose an amount such that the volume of solids is

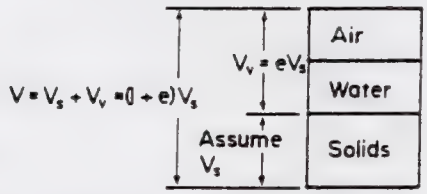


Fig. 2.6—Phase diagram for Example 2.1.

By Definition

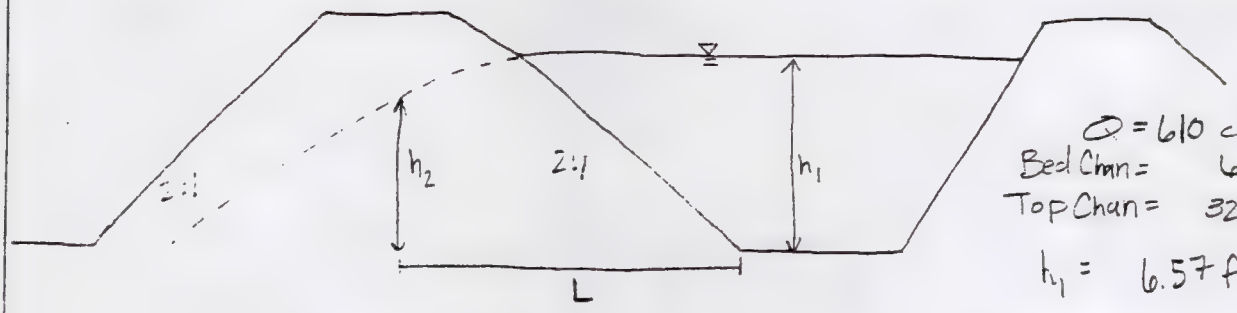
$$n = \frac{V_v}{V} = \frac{e}{1+e}$$

V_s; the quantities shown in the diagram then follow directly from definitions. When the choice of quantity of material is arbitrary, it is often convenient to choose the denominator of one of the given items.

Table 5-1.—Average engineering properties of compacted soils. From the Western United States. Last updated October 6, 1982.

USCS soil type	Specific gravity		Compaction				Shear strength				Values listed
			Laboratory		Index unit weight		Avg. placement		Effective stress		
	No. 4 minus	No. 4 plus	Maximum unit weight, lb/ft³	Optimum moisture content, %	Max., lb/ft³	Min., lb/ft³	Unit weight, lb/ft³	Moisture, content, %	c′ lb/in²	φ′, degrees	
	2.69	2.58	124.2	11.4	133.6	108.8	—	—	—	—	Average of all values
	0.02	0.08	3.2	1.2	10.4	10.2	—	—	—	—	Standard deviation
GW	2.65	2.39	119.1	9.9	113.0	88.5	—	—	—	—	Minimum value
	2.75	2.67	127.5	13.3	145.6	132.9	—	—	—	—	Maximum value
	16	9	5		16				0		Total number of tests
	2.68	2.57	121.7	11.2	137.2	112.5	127.5	6.5	5.9	41.4	Average of all values
	0.03	0.07	5.9	2.2	6.3	8.3	7.2	1.2	—	2.5	Standard deviation
GP	2.61	2.42	104.9	9.1	116.3	85.9	117.4	5.3	5.9	38.0	Minimum value
	2.76	2.65	127.7	17.7	148.8	123.7	133.9	8.0	5.9	43.7	Maximum value
	35	12	15		34				3		Total number of tests
	2.73	2.43	113.3	15.8	132.0	108.0	125.9	10.3	13.4	34.0	Average of all values
	0.07	0.18	11.5	5.6	3.1	0.2	0.9	1.2	3.7	2.6	Standard deviation
GM	2.65	2.19	87.0	5.8	128.9	107.6	125.0	9.1	9.7	31.4	Minimum value
	2.92	2.92	133.0	29.5	135.1	108.1	126.9	11.5	17.0	36.5	Maximum value
	34	17	36		2				2		Total number of tests
	2.73	2.57	116.6	13.9	—	—	111.1	15.9	10.2	27.5	Average of all values
	0.08	0.21	7.6	3.8	—	—	10.4	1.6	1.5	7.2	Standard deviation
GC	2.67	2.38	96.0	6.0	—	—	96.8	11.2	5.0	17.7	Minimum value
	3.11	2.94	129.0	23.6	—	—	120.9	22.2	16.0	35.0	Maximum value
	34	6	37		0				3		Total number of tests
	2.67	2.57	126.1	9.1	125.0	99.5	—	—	—	—	Average of all values
	0.03	0.03	6.0	1.7	6.0	7.1	—	—	—	—	Standard deviation
SW	2.61	2.51	118.1	7.4	116.7	87.4	—	—	—	—	Minimum value
	2.72	2.59	135.0	11.2	137.8	109.8	—	—	—	—	Maximum value
	13	2	1		12				0		Total number of tests
	2.65	2.62	115.6	10.8	115.1	93.4	103.4	5.4	5.5	37.4	Average of all values
	0.03	0.10	9.7	2.0	7.2	8.8	14.6	—	3.0	2.0	Standard deviation
SP	2.60	2.52	106.5	7.8	105.9	78.2	88.8	5.4	2.5	35.4	Minimum value
	2.77	2.75	134.8	13.4	137.3	122.4	116.1	5.4	8.4	39.4	Maximum value
	36	3	7		39				2		Total number of tests
	2.68	2.18	116.6	12.5	110.1	84.9	112.0	12.7	6.6	33.6	Average of all values
	0.06	0.11	8.9	3.4	8.7	7.9	11.1	5.4	5.6	5.7	Standard deviation
SM	2.51	2.24	92.9	6.8	88.5	61.6	91.1	1.6	0.2	23.3	Minimum value
	3.11	2.63	132.6	25.5	122.9	97.1	132.5	25.0	21.2	45.0	Maximum value
	149	9	123		21				17		Total number of tests
	2.69	2.17	118.9	12.4	—	—	115.6	14.2	5.0	33.9	Average of all values
	0.04	0.18	5.9	2.3	—	—	14.1	5.7	2.5	2.9	Standard deviation
SC	2.56	2.17	104.3	6.7	—	—	91.1	7.5	0.7	28.4	Minimum value
	2.81	2.59	131.7	18.2	—	—	131.8	22.7	8.5	38.3	Maximum value
	88	4	73		0				10		Total number of tests
	2.69	—	103.3	19.7	—	—	98.9	22.1	3.6	34.0	Average of all values
	0.09	—	10.4	5.7	—	—	11.5	8.9	4.3	3.1	Standard deviation
ML	2.52	—	81.6	10.6	—	—	80.7	11.1	0.1	25.2	Minimum value
	3.10	—	126.0	34.6	—	—	119.3	40.3	11.9	37.7	Maximum value
	65	0	39		0				14		Total number of tests
	2.71	2.59	109.3	16.7	—	—	106.5	17.7	10.3	25.1	Average of all values
	0.05	0.13	5.5	2.9	—	—	7.8	5.1	7.6	7.0	Standard deviation
CL	2.56	2.42	90.0	6.4	—	—	85.6	11.6	0.9	8.0	Minimum value
	2.87	2.75	121.4	29.2	—	—	118.7	35.0	23.8	33.8	Maximum value
	270	3	221		0				31		Total number of tests
	2.79	—	85.1	33.6	—	—	—	—	—	—	Average of all values
	0.25	—	2.3	1.6	—	—	—	—	—	—	Standard deviation
MH	2.47	—	82.9	31.5	—	—	—	—	—	—	Minimum value
	3.50	—	89.0	35.5	—	—	—	—	—	—	Maximum value
	10	0	5		0				0		Total number of tests

LEVEE DESIGN FOR DEWATERING DITCH



$Q = 610$ cfs
Bed Chan = 6 ft
Top Chan = 32.28 ft
$h_1 = 6.57$ ft

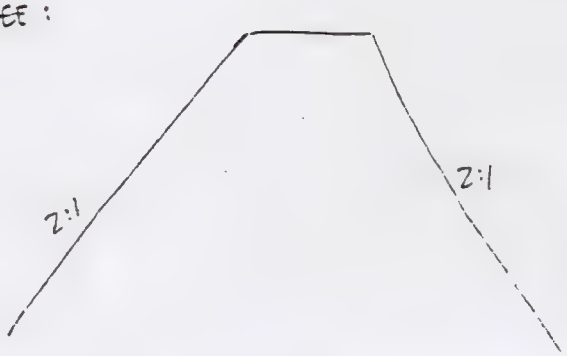
$$q' = \frac{1}{2} K \left(\frac{h_1^2 - h_2^2}{L} \right)$$ DUPUIT Eqn (Fetter pg 164)

$q = \frac{Q}{\text{Avg width}} = 21.87 \text{ ft}^2/\text{s}$

K = Conductivity of soil = $35 \text{ gal/day/ft}^2 = 6.5 \times 10^{-5}$ ft/s
(Value obtained from Maxium for a silty clayey soil used in the first reach. This number is approximately a silty sand according to soil characteristics chart, using this number is a conservative estimate because it would be the largest conductivity for the soils found in the area.)

$\Rightarrow L \geq 4.4 \times 10^{-5}$ ft

LEVEE:



22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS
AMPAD

Silver Bow SSTOU, Subarea 1, Reach A Design
D. White, 4/7/98

Calculation of superelevation of water surface at sharp bend (D2+00 - D3+00

Superelevation (D) = (V^2*T)/(gR)*

Where: V = mean velocity
T = channel surface width
g = gravitational constant
R = bend radius of curvature

From Hec-Ras output and plan map:
V = 6.3 (from diversion channel model @ 800 cfs)
T = 29 ft
g = 32.2 ft/sec^2
R = 75 ft

D = 39.7(29)/32.2(75) = 0.5 ft

* from Design of Roadside Channels with Flexible Linings, FHWA Hec 15

Calculation of superelevation of water surface at diversion structure

Superelevation (D) = (V^2*T)/(gR)*

Where: V = mean velocity
T = channel surface width
g = gravitational constant
R = bend radius of curvature

From Hec-Ras output and plan map:
V = 6 (from reconstructed channel model @ 1042 cfs)
T = 40 ft
g = 32.2 ft/sec^2
R = 120 ft

D = 36(40)/32.2(120) = 0.4 ft

* from Design of Roadside Channels with Flexible Linings, FHWA Hec 15

Project:	Silver Bow Creek, SSTOU, Subarea 1, Reach A Design
Name:	DW
Date:	4/6/98

Notes: Sizing riprap for diversion ditch station 236 (HEC XS 955.3 at 610 cfs) at sharp bend - radius 75 ft

Needed for method:	Parameter			units	Generally assumed to be	counter
12	Shield's Parameter		0.047		0.047	1
	Hydraulic Radius		3.37	ft		1
2	Shear Stress		0.86	lb/ft^2		1
1	Depth (average)		6	ft		1
4	Depth (local)		6.2	ft		1
1234	Specific Gravity of Rock Riprap		2.65		2.65	1
123	Unit Weight of Sediment		165.4	lb/ft^3	165.4	1
1234	Unit Weight of Water		62.4	lb/ft^3	62.4	1
1234	Slope Angle (side slope with horizontal)		26.6	degrees		1
1234	Angle of Repose		36	degrees		1
1	Energy Gradient		0.00407	ft/ft		1
34	Velocity (average)		6.1	ft/sec		1
4	Bend Radius of Curvature		75	ft		1
4	Width of Water Surface		26.2	ft		1
4	Enter 1 if trapezoidal channel, 2 if natural		1			1
4	Enter 1 if straight channel or outside bend with r/w>26 or enter 2 if outside bend with r/w<26		2			1
1234	Gravitational Constant		32.2	ft/sec^2	32.2	1
4	Stability Coefficient	(0.3 for angular rock and 0.36 for round)	0.36			1
124	Safety Factor		1.8			1
	1.0 to 1.2	Uniform flow, straight to mildly curving, r/w > 30, wave and debris impact minimal, no uncertainty in parameters				
	1.3 to 1.6	Gradually varying flow, moderate bed 10<r/w<30 wave and debris impact moderate				
	1.6 to 2.0	Approaching rapidly varying flow, sharp bend r/w < 10 significant impact, high turbulence, uncertainty in parameters				

Output		ft	inches	mm	# of paramters	Check
1. FHWA Energy Slope Method	D50	0.87	10.50	266.67	10	Data OK
2. FHWA Shear Method	D50	0.49	5.92	150.45	9	Data OK
3. Isbash Velocity Method	D50	0.27	3.26	82.84	7	Data OK
Average		0.55	6.56	166.65		

Project: Silver Bow Creek, SSTOU, Subarea 1, Reach A Design
Name: DW
Date: 4/5/98

Notes: Sizing riprap for diversion ditch station 375 (HEC XS 955.15 at 610 cfs)

Needed for method:	Parameter			units	Generally assumed to be	counter
12	Shield's Parameter		0.047		0.047	1
	Hydraulic Radius		3.6	ft		1
2	Shear Stress		0.6	lb/ft^2		1
1	Depth (average)		6	ft		1
4	Depth (local)		6.6	ft		1
1234	Specific Gravity of Rock Riprap		2.65		2.65	1
123	Unit Weight of Sediment		165.4	lb/ft^3	165.4	1
1234	Unit Weight of Water		62.4	lb/ft^3	62.4	1
1234	Slope Angle (side slope with horizontal)		26.6	degrees		1
1234	Angle of Repose		36	degrees		1
1	Energy Gradient		0.002584	ft/ft		1
34	Velocity (average)		5.12	ft/sec		1
4	Bend Radius of Curvature		200	ft		1
4	Width of Water Surface		29.2	ft		1
4	Enter 1 if trapezoidal channel, 2 if natural		1			1
4	Enter 1 if straight channel or outside bend with r/w>26 or enter 2 if outside bend with r/w<26		2			1
1234	Gravitational Constant		32.2	ft/sec^2	32.2	1
4	Stability Coefficient	(0.3 for angular rock and 0.36 for round)	0.36			1
124	Safety Factor		1.5			1
	1.0 to 1.2	Uniform flow, straight to mildly curving, r/w > 30, wave and debris impact minimal, no uncertainty in parameters				
	1.3 to 1.6	Gradually varying flow, moderate bed 10<r/w<30 wave and debris impact moderate				
	1.6 to 2.0	Approaching rapidly varying flow, sharp bend r/w < 10 significant impact, high turbulence, uncertainty in parameters				

Output		ft	Inches	mm	# of paramters	Check
1. FHWA Energy Slope Method	D50	0.46	5.55	141.09	10	Data OK
2. FHWA Shear Method	D50	0.29	3.44	87.47	9	Data OK
3. Isbash Velocity Method	D50	0.19	2.30	58.36	7	Data OK
Average		0.31	3.77	95.64		

Project: Silver Bow Creek, SSTOU, Subarea 1, Reach A Design
Name: DW
Date: 4/6/98

Notes: Sizing riprap for diversion ditch station 2192 (HEC XS 937 at 610 cfs)

Needed for method:	Parameter			units	Generally assumed to be	counter
12	Shield's Parameter		0.047		0.047	1
	Hydraulic Radius		3.5	ft		1
2	Shear Stress		0.57	lb/ft^2		1
1	Depth (average)		6	ft		1
4	Depth (local)		6.6	ft		1
1234	Specific Gravity of Rock Riprap		2.65		2.65	1
123	Unit Weight of Sediment		165.4	lb/ft^3	165.4	1
1234	Unit Weight of Water		62.4	lb/ft^3	62.4	1
1234	Slope Angle (side slope with hortzontal)		26.6	degrees		1
1234	Angle of Repose		36	degrees		1
1	Energy Gradient		0.002631	ft/ft		1
34	Velocity (average)		5	ft/sec		1
4	Bend Radius of Curvature		200	ft		1
4	Width of Water Surface		31.6	ft		1
4	Enter 1 if trapezoidal channel, 2 if natural		1			1
4	Enter 1 if straight channel or outside bend with r/w>26 or enter 2 if outside bend with r/w<26		2			1
1234	Gravitational Constant		32.2	ft/sec^2	32.2	1
4	Stability Coefficient	(0.3 for angular rock and 0.36 for round)	0.36			1
124	Safety Factor		1.5			1
	1.0 to 1.2	Uniform flow, straight to mildly curving, r/w > 30, wave and debris impact minimal, no uncertainty in parameters				
	1.3 to 1.6	Gradually varying flow, moderate bed 10<r/w<30 wave and debris impact moderate				
	1.6 to 2.0	Approaching rapidly varying flow, sharp bend r/w < 10 significant impact, high turbulence, uncertainty in parameters				

Output		ft	inches	mm	# of paramters	Check
1. FHWA Energy Slope Method	D50	0.47	5.66	143.66	10	Data OK
2. FHWA Shear Method	D50	0.27	3.27	83.10	9	Data OK
3. Isbash Velocity Method	D50	0.18	2.19	55.66	7	Data OK
Average		0.31	3.71	94.14		

Project: Silver Bow
Name: DW
Date: 4/6/98

Notes: Sizing riprap for diversion ditch station 4692 (HEC XS 916 at 610 cfs)

Needed for method:	Parameter			units	Generally assumed to be	counter
12	Shield's Parameter		0.047		0.047	1
	Hydraulic Radius		3.1	ft		1
2	Shear Stress		0.91	lb/ft^2		1
1	Depth (average)		5	ft		1
4	Depth (local)		6.3	ft		1
1234	Specific Gravity of Rock Riprap		2.65		2.65	1
123	Unit Weight of Sediment		165.4	lb/ft^3	165.4	1
1234	Unit Weight of Water		62.4	lb/ft^3	62.4	1
1234	Slope Angle (side slope with horizontal)		26.6	degrees		1
1234	Angle of Repose		36	degrees		1
1	Energy Gradient		0.004696	ft/ft		1
34	Velocity (average)		6.2	ft/sec		1
4	Bend Radius of Curvature		200	ft		1
4	Width of Water Surface		29	ft		1
4	Enter 1 if trapezoidal channel, 2 if natural		1			1
4	Enter 1 if straight channel or outside bend with r/w>26 or enter 2 if outside bend with r/w<26		2			1
1234	Gravitational Constant		32.2	ft/sec^2	32.2	1
4	Stability Coefficient	(0.3 for angular rock and 0.36 for round)	0.36			1
124	Safety Factor		1.5			1
	1.0 to 1.2	Uniform flow, straight to mildly curving, r/w > 30, wave and debris impact minimal, no uncertainty in parameters				
	1.3 to 1.6	Gradually varying flow, moderate bed 10<r/w<30 wave and debris impact moderate				
	1.6 to 2.0	Approaching rapidly varying flow, sharp bend r/w < 10 significant impact, high turbulence, uncertainty in parameters				

Output		ft	inches	mm	# of paramters	Check
1. FHWA Energy Slope Method	D50	0.84	10.09	256.41	10	Data OK
2. FHWA Shear Method	D50	0.44	5.22	132.66	9	Data OK
3. Isbash Velocity Method	D50	0.28	3.37	85.58	7	Data OK
Average		0.52	6.23	158.22		

Project:	Silver Bow Creek, SSTOU, Subarea 1, Reach A Design
Name:	DW
Date:	4/6/98

Notes: Sizing riprap for diversion ditch station 5192 (HEC XS 915 at 610 cfs)

Needed for method:	Parameter			units	Generally assumed to be	counter
12	Shield's Parameter		0.047		0.047	1
	Hydraulic Radius		3.2	ft		1
2	Shear Stress		1.03	lb/ft^2		1
1	Depth (average)		5.5	ft		1
4	Depth (local)		5.95	ft		1
1234	Specific Gravity of Rock Riprap		2.65		2.65	1
123	Unit Weight of Sediment		165.4	lb/ft^3	165.4	1
1234	Unit Weight of Water		62.4	lb/ft^3	62.4	1
1234	Slope Angle (side slope with horizontal)		26.6	degrees		1
1234	Angle of Repose		36	degrees		1
1	Energy Gradient		0.005212	ft/ft		1
34	Velocity (average)		6.61	ft/sec		1
4	Bend Radius of Curvature		200	ft		1
4	Width of Water Surface		29.2	ft		1
4	Enter 1 if trapezoidal channel, 2 if natural		1			1
4	Enter 1 if straight channel or outside bend with r/w>26 or enter 2 if outside bend with r/w<26		2			1
1234	Gravitational Constant		32.2	ft/sec^2	32.2	1
4	Stability Coefficient	(0.3 for angular rock and 0.36 for round)	0.36			1
124	Safety Factor		1.5			1
	1.0 to 1.2	Uniform flow, straight to mildly curving, r/w > 30, wave and debris impact minimal, no uncertainty in parameters				
	1.3 to 1.6	Gradually varying flow, moderate bed 10<r/w<30 wave and debris impact moderate				
	1.6 to 2.0	Approaching rapidly varying flow, sharp bend r/w < 10 significant impact, high turbulence, uncertainty in parameters				

Output		ft	inches	mm	# of paramters	Check
1. FHWA Energy Slope Method	D50	0.86	10.27	260.87	10	Data OK
2. FHWA Shear Method	D50	0.49	5.91	150.15	9	Data OK
3. Isbash Velocity Method	D50	0.32	3.83	97.27	7	Data OK
Average		0.56	6.67	169.43		

INTER-FLUVE, INC.

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MEMORANDUM

To: *Silver Bow Creek, SSTOU SubArea 1, Reach A*
From: *Martin Doyle, Shelly Donner*
Date: *4/7/98*
In Regards To: *Erosion Protection and Grade Control at Downstream End of Diversion Channel and Reach A*

At the transition from the diversion channel to the existing channel there is a significant change in the cross-sectional shape, the flow changes from a confined trapezoidal section to a shallow channel and open floodplain. This produces a hydraulic jump. This jump results in high shears and velocities in the transition from diversion channel to channel. These high shear areas extend downstream. A grade control was incorporated as an alternate to extensive protection based on the following considerations:

1. The downstream channel/floodplain is to be reconstructed (within the next year?). Hence, any damage done to the existing channel/floodplain associated with the transition will be of little concern pending its reconstruction. The construction of the grade controls is to prevent any damage occurring in the reconstructed channel and the dewatering diversion channel.

2. Due to the high shears/velocities associated with the jump, extremely large rock would be needed to protect the channel and floodplain (D50 > 12 inches, flow of 440-cfs, rock sizes would increase with an increase in flow). This rock would be needed both in the dewatering diversion channel and the existing channel as well as along the adjacent floodplain. The cost implications of the size and quantity of rock needed made less extensive options attractive. By designing the grade control structure for a flow of 610cfs the risk of failure has decreased to 10% each year.

The implication of not extensively protecting the channel downstream of the transition is that subsequent downstream erosion could form a headcut. Hence, there was concern that such a headcut could migrate upstream into the diversion channel and/or the reconstructed channel. This concern was remedied through grade control structures being designed near the exits of the diversion channel and the reconstructed channel.

The following pages show the design calculations that were used to design both the short-term grade control structures for a flow of 610-cfs, and the long term riprap section for a flow of 440-cfs. Included are rough sketches of the two different plans, and the analysis of the hydraulic jump, incipient motion and scour at the outflow of the diversion channel.

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS

Dewatering Ditch

Short term: Grade Control

S. Donner 1/24/08

Jump

← Q = blocks

Existing Channel

Dewatering Ditch

20'

D_{50}=8"

3.5'

D_{50}=16"

Slope

160'

10'

D_{50}=16"

33'

← Existing Channel

← Dewatering Ditch

Primary Grade Control

33'×10'×3.5' = 1149 cuft of D_{50}=16"

Secondary Grade Control

20×16'×2' = 400 cuft of D_{50}=8"

D_{50}=8"

20'

4.0

← New Channel

Secondary gradation

$d_s = 2.1'$

GENERAL/CONSTRICTION SCOUR COMPUTATIONS

Page 1/3

Based on: B.O.R. Methodology "Computing Degradation and Local Scour" 1984

Stream/River:	Silver Bow	Name:	Shelly Donner
Cross-section:	910	Date:	26-Feb-98
Notes:	transition from dewatering ditch to existing channel, with a hydraulic jump		
	Q= 610 cfs		

df = scoured depth below designed floodwater level
di = average depth at bankfull discharge in incised reach (reach which "spills" only at high Q)
qf = designed flood discharge per unit width
qi = bankfull discharge per unit width in incised reach (reach which "spills" only at high Q)
m = exponent 0.67 for sand, 0.85 for gravel

di =	6	ft.
bank full top width =	27.12	ft.
design flow top width =	23.65	ft
design discharge =	610	cfs
bankfull discharge =	800	cfs
m =	0.85	

qf = 25.79
qi = 29.50

Neill Equation

Uses field measurements from "incised" reach

df = di * (qf/qi)^m

df = 5.35 ft

Lacey Equation

Includes empirical regime equation by Lacey, and method of zero bed-sediment transport by Blench.

dm = 0.47*(Q/f)^(1/3)

dm = mean depth at design discharge (ft.)
Q = design discharge (cfs)
f = silt factor f = 1.76*(Dm)^0.5
Dm = mean grain size of bed materials in mm

range:
D(50) = 8 inches = 203.2 mm

dm = 1.36 ft

GENERAL/CONSTRICTION SCOUR COMPUTATIONS

Blench Equation

Dfo = qf^(2/3)/Fbo^(1/3)

Dfo = depth for zero bed sediment transport (ft.)
qf = design flood discharge per unit width (cfs/ft)
Fbo = Blench's zero bed factor (ft/s^2)

for above D(50):
Fbo (from figure 9) = 6.5 ft/s^2

Dfo = 4.68 ft

Depth of Scour

ds = Zn*df
ds = Zl*dm
ds = Zb*dfo

ds = depth of scour below streambed
Zn = Neill, empirically developed multiplication factor
Zl = Lacey, empirically developed multiplication factor
Zb = Blench, empirically developed multiplication factor

General/Constriction Scour		Bend Scour*			
Multiplication factor	Straight reach	Moderate bend	Severe bend	Right angle bend	Vertical wall
Zn	0.5	0.6	0.7		
Zl	0.25	0.5	0.75	1	1.25
Zb	0.6	0.6	0.6	1.25	

Local Scour*	
Multiplication factor	Nose of pier
Zn	1
Zl	
Zb	1

Spur Scour*
Nose of spur dikes
0.7
1.75
1.75

Weir Scour*
Grade control or small dam
1.5
1.25

* Use these for rough calculations only, equations specific to these scour types should be used for more accuracy

GENERAL/CONSTRICTION SCOUR COMPUTATIONS

PREDICTED SCOUR DEPTHS (FT)

Equation	Straight reach	Moderate bend*	Severe bend*	Right angle bend*	Vertical wall*
Neill ds =	2.7	3.2	3.7		
Lacey ds =	0.3	0.7	1.0	1.4	1.7
Blench ds =	2.8	2.8	2.8	5.8	
ds (average) =	1.9	2.2	2.5	3.6	1.7

Equation	Nose of pier*		Nose of spur dikes*		Grade control or small dam*
Neill ds =	5.4		3.7		
Lacey ds =			2.4		2.0
Blench ds =	4.7		8.2		5.8
ds (average) =	5.0		4.8		3.9

* Use these for rough calculations only, equations specific to these scour types should be used for more accuracy

Primary Grade Control

Project: Silver Bow (transition from ditch to channel - jump) Q=610 CFS
Name: Shelly Donner
Date: 24-Feb-98

Needed for method:	Parameter		units	Generally assumed to be
12	Shield's Paramter	0.03		0.047
	Hydraulic Radius	2.38	ft	
2	Shear Stress	2.3	lb/ft^2	
1	Depth (channel average	6	ft	
4	Depth (local)	4.62	ft	
1234	Specific Gravity of Rock Riprap	2.65		2.65
123	Unit Weight of Sediment	165.4	lb/ft^3	165.4
1234	Unit Weight of Water	62.4	lb/ft^3	62.4
1234	Slope Angle (side slope with horizonta	26.6	degrees	
1234	Angle of Repose	38	degrees	
1	Energy Gradien	0.015	ft/ft	
34	Velocity (average	9.266	ft/sec	
4	Bend Radius of Curvatur	1000	ft	
4	Width of Water Surface	26	ft	
4	Enter 1 if trapezoidal channel, 2 if natur	2		
4	Enter 1 if straight channel or outside bend with r/w>2 or enter 2 if outside bend with r/w<2	1		
1234	Gravitational Constan	32.2	ft/sec^2	32.2
4	Stability Coefficent (0.3 for angular rock and 0.36 for round	0.36		
124	Safety Factor	1.5		

Output		ft	inches	mm	# of paramters	Check
1. FHWA Energy Slope Method	D50	3.97	47.68	1211.17	10	Data OK
2. FHWA Shear Method	D50	1.63	19.52	495.83	9	Data OK
3. Isbash Velocity Method	D50	0.63	7.53	191.15	7	Data OK
4. ACOE (seen note below)	D30	0.86	10.35	262.79	13	Data OK
5. Basic Shields Relation for incipient motion	D50	0.74	8.93	226.87	5	Data OK

The ACOE approach is extremely sensative to velocity.

Analysis

Method =

1 - to high because method uses slope to calculate shear, given the ~~high~~ steep slope a higher shear is used than actual shear.

2 - acceptable

3 - generally considered to be a low estimate

4 - acceptable D_{30} => D_{50} = 14.79"

5 - acceptable, but does not have a safety factor with safety factor = 13.40"

Average of acceptable methods

19.52
14.79
13.40

=> 15.9

D_{50} = 16"

Primary Grade Contro

Straight reach scou

Grade Control scour =

GENERAL/CONSTRICTION SCOUR COMPUTATIONS

Based on: B.O.R. Methodology "Computing Degradation and Local Scour" 1984

Stream/River:	Silver Bow	Name:	Shelly Donner
Cross-section:	910	Date:	26-Feb-98
Notes:	transition from dewatering ditch to existing channel, with a hydraulic jump		
	Q= 610 cfs		

df = scoured depth below designed floodwater level
di = average depth at bankfull discharge in incised reach (reach which "spills" only at high Q)
qf = designed flood discharge per unit width
qi = bankfull discharge per unit width in incised reach (reach which "spills" only at high Q)
m = exponent 0.67 for sand, 0.85 for gravel

di =	6	ft.	qf =	25.79
bank full top width =	27.12	ft.	qi =	29.50
design flow top width =	23.65	ft		
design discharge =	610	cfs		
bankfull discharge =	800	cfs		
m =	0.85			

Neill Equation

Uses field measurements from "incised" reach

df = di * (qf/qi)^m

df = 5.35 ft

Lacey Equation

Includes empirical regime equation by Lacey, and method of zero bed-sediment transport by Blench.

dm = 0.47*(Q/f)^(1/3)

dm = mean depth at design discharge (ft.)
Q = design discharge (cfs)
f = silt factor f = 1.76*(Dm)^0.5
Dm = mean grain size of bed materials in mm

range:

D(50) = 16 inches = 406.4 mm

dm = 1.21 ft

GENERAL/CONSTRICTION SCOUR COMPUTATIONS

Blench Equation

Dfo = qf^(2/3)/Fbo^(1/3)

Dfo = depth for zero bed sediment transport (ft.)
qf = design flood discharge per unit width (cfs/ft)
Fbo = Blench's zero bed factor (ft/s^2)

for above D(50):
Fbo (from figure 9) = 9 ft/s^2

Dfo = 4.20 ft

Depth of Scour

ds = Zn*df
ds = Zl*dm
ds = Zb*dfo

ds = depth of scour below streambed
Zn = Neill, empirically developed multiplication factor
Zl = Lacey, empirically developed multiplication factor
Zb = Blench, empirically developed multiplication factor

General/Constriction Scour		Bend Scour*			
Multiplication factor	Straight reach	Moderate bend	Severe bend	Right angle bend	Vertical wall
Zn	0.5	0.6	0.7		
Zl	0.25	0.5	0.75	1	1.25
Zb	0.6	0.6	0.6	1.25	

Local Scour*	
Multiplication factor	Nose of pier
Zn	1
Zl	
Zb	1

Spur Scour*
Nose of spur dikes
0.7
1.75
1.75

Weir Scour*
Grade control or small dam
1.5
1.25

* Use these for rough calculations only, equations specific to these scour types should be used for more accuracy

GENERAL/CONSTRICTION SCOUR COMPUTATIONS

PREDICTED SCOUR DEPTHS (FT)

Equation	Straight reach	Moderate bend*	Severe bend*	Right angle bend*	Vertical wall*
Neill ds =	2.7	3.2	3.7		
Lacey ds =	0.3	0.6	0.9	1.2	-1.5
Blench ds =	2.5	2.5	2.5	5.2	
ds (average) =	1.8	2.1	2.4	3.2	1.5

Equation	Nose of pier*		Nose of spur dikes*		Grade control or small dam*
Neill ds =	5.4		3.7		
Lacey ds =			2.1		1.8
Blench ds =	4.2		7.3		5.2
ds (average) =	4.8		4.4		3.5

* Use these for rough calculations only, equations specific to these scour types should be used for more accuracy

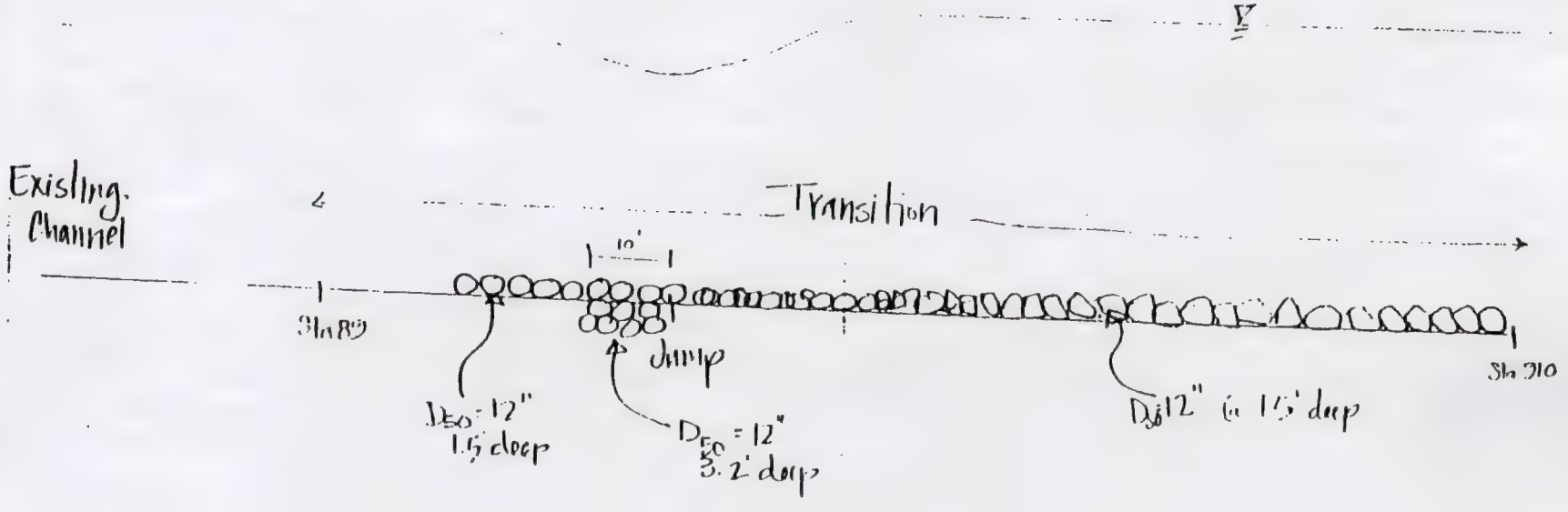
Q=140cfs

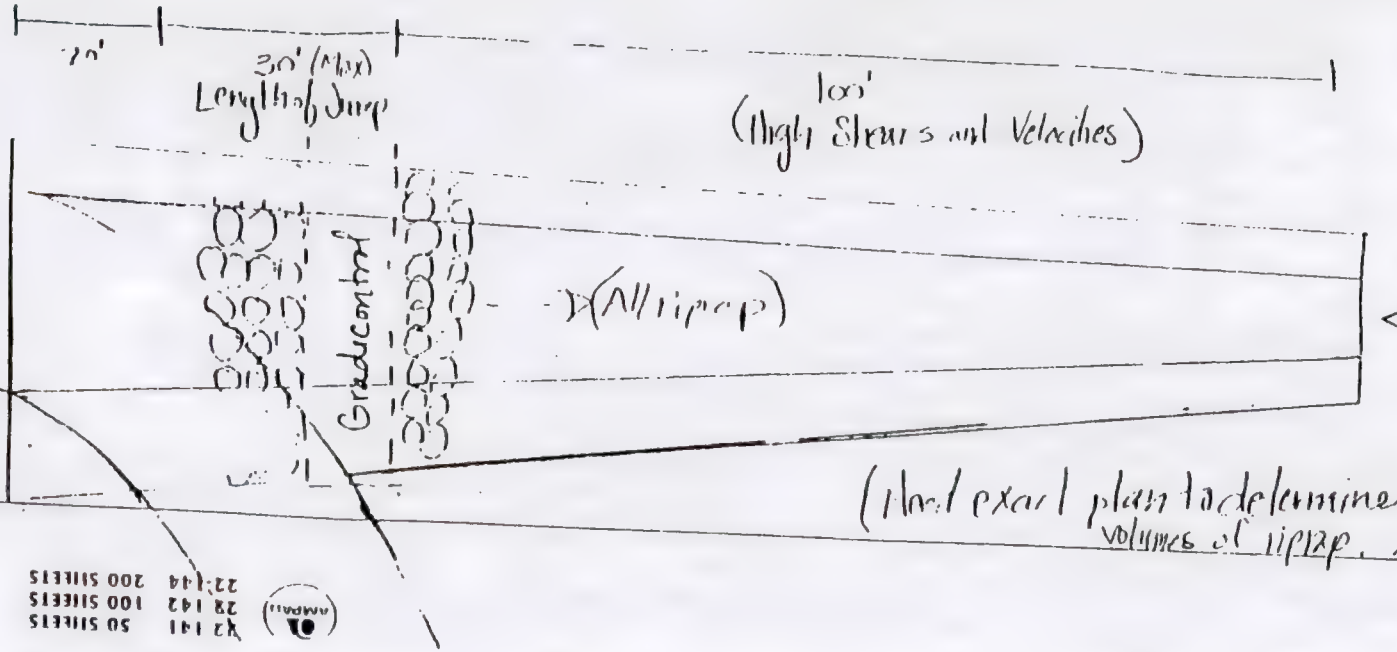
S. Donner 2/16/98

Silver Bow

Dewatering Ditch

Existing Channel





Dewatering Ditch

Long term Pipe

Long term: Riprap

Project: Silver Bow (transition from ditch to channel - jump) Q=440 CFS
Name: Shelly Donner
Date: 25-Feb-98

Needed for method:	Parameter			Generally assumed to be
12	Shield's Paramte		units	
	Hydraulic Radius	0.03		0.047
2	Shear Stress	2.32	ft	
1	Depth (channel average	1.36	lb/ft^2	
4	Depth (local)	6	ft	
1234	Specific Gravity of Rock Riprap	4	ft	
123	Unit Weight of Sediment	2.65		2.65
1234	Unit Weight of Water	165.4	lb/ft^3	165.4
1234	Slope Angle (side slope with horizonta	62.4	lb/ft^3	62.4
1234	Angle of Repose	26.6	degrees	
1	Energy Gradien	38	degrees	
34	Velocity (average	0.014	ft/ft	
4	Bend Radius of Curvatur	8.12	ft/sec	
4	Width of Water Surface	1000	ft	
4	Enter 1 if trapezoidal channel, 2 if natur	22.57	ft	
4	Enter 1 if straight channel or outside bend with r/w>2 or enter 2 if outside bend with r/w<2	2		
		1		
1234	Gravitational Constan	32.2	ft/sec^2	32.2
4	Stability Coefficient (0.3 for angular rock and 0.36 for round	0.36		
124	Safety Factor	1.5		

Output		ft	inches	mm	# of paramters	Check
1. FHWA Energy Slope Method	D50	3.71	44.50	1130.42	10	Data OK
2. FHWA Shear Method	D50	1.32	15.79	400.98	9	Data OK
3. Isbash Velocity Method	D50	0.48	5.78	146.79	7	Data OK
4. ACOE (seen note below)	D30	0.59	7.12	180.73	13	Data OK
5. Basic Shields Relation for incipient motion	D50	0.60	7.22	183.47	5	Data OK

The ACOE approach is extremely sensative to velocity.

Analysis = method =

1 - to high, because Slope is used to calculate shear, and the slope is high, giving a higher shear than actual shear.

2 - acceptable

3 - generally considered to be a low estimate

4 - acceptable D_{30}, $D_{50} = 10"$

5 - acceptable but does not have a factor of safety with S.F Shields = 10.83

Average of acceptable methods = $\frac{15.79 + 10.00 + 10.83}{3} = 12.2$ (≈ 12")

Riprap

Depth of Scour -
Grade Control 3.2ft
Straight Reach 1.5ft

GENERAL/CONSTRICTION SCOUR COMPUTATIONS

Page 1/3

Based on: B.O.R. Methodology "Computing Degradation and Local Scour" 1984

Stream/River:	Silver Bow	Name:	Shelly Donner
Cross-section:	910	Date:	24-Feb-98
Notes:	transition from dewatering ditch to existing channel, with a hydraulic jump		
	Q= 440 cfs		

df = scoured depth below designed floodwater level
di = average depth at bankfull discharge in incised reach (reach which "spills" only at high Q)
qf = designed flood discharge per unit width
qi = bankfull discharge per unit width in incised reach (reach which "spills" only at high Q)
m = exponent 0.67 for sand, 0.85 for gravel

di =	6	ft.
bank full top width =	27.12	ft.
design flow top width =	22.87	ft
design discharge =	440	cfs
bankfull discharge =	800	cfs
m =	0.85	

qf = 19.24
qi = 29.50

Neill Equation

Uses field measurements from "incised" reach

df = di * (qf/qi)^m

df = 4.17 ft

Lacey Equation

Includes empirical regime equation by Lacey, and method of zero bed-sediment transport by Blench.

dm = 0.47*(Q/f)^(1/3)

dm = mean depth at design discharge (ft.)
Q = design discharge (cfs)
f = silt factor f = 1.76*(Dm)^0.5
Dm = mean grain size of bed materials in mm

range:
D(50) = 12 inches = 304.8 mm

dm = 1.14 ft

Riprap

GENERAL/CONSTRICTION SCOUR COMPUTATIONS

Blench Equation

Dfo = qf^(2/3)/Fbo^(1/3)

Dfo = depth for zero bed sediment transport (ft.)
qf = design flood discharge per unit width (cfs/ft)
Fbo = Blench's zero bed factor (ft/s^2)

for above D(50):
Fbo (from figure 9) = 7 ft/s^2

Dfo = 3.75 ft

Depth of Scour

ds = Zn*df
ds = Zl*dm
ds = Zb*dfo

ds = depth of scour below streambed
Zn = Neill, empirically developed multiplication factor
Zl = Lacey, empirically developed multiplication factor
Zb = Blench, empirically developed multiplication factor

General/Constriction Scour		Bend Scour*			
Multiplication factor	Straight reach	Moderate bend	Severe bend	Right angle bend	Vertical wall
Zn	0.5	0.6	0.7		
Zl	0.25	0.5	0.75	1	1.25
Zb	0.6	0.6	0.6	1.25	

Local Scour*	
Multiplication factor	Nose of pier
Zn	1
Zl	
Zb	1

Spur Scour*
Nose of spur dikes
0.7
1.75
1.75

Weir Scour*
Grade control or small dam
1.5
1.25

* Use these for rough calculations only, equations specific to these scour types should be used for more accuracy

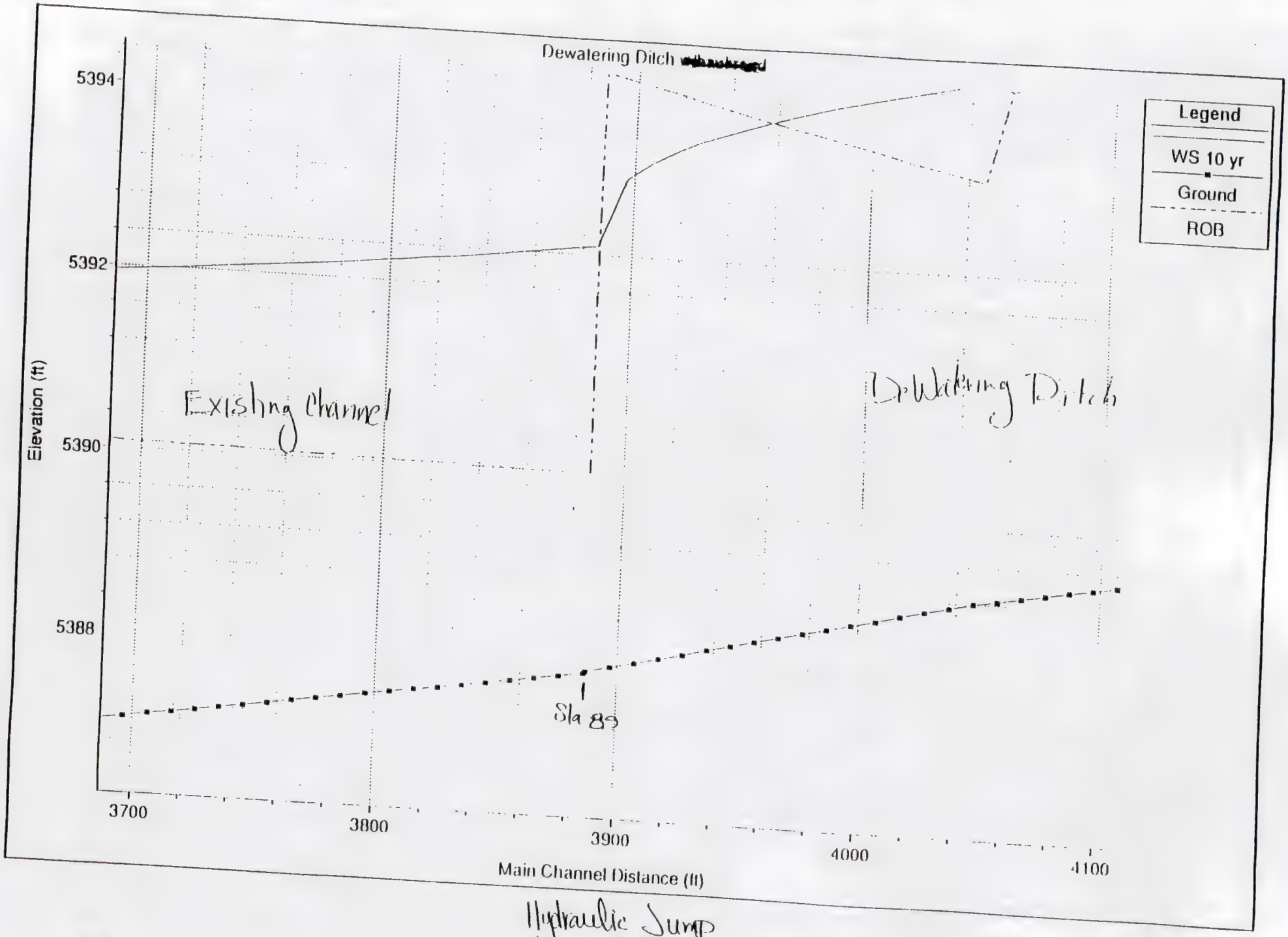
GENERAL/CONSTRICTION SCOUR COMPUTATIONS

PREDICTED SCOUR DEPTHS (FT)

Equation	Straight reach	Moderate bend*	Severe bend*	Right angle bend*	Vertical wall*
Neill ds =	2.1	2.5	2.9		
Lacey ds =	0.3	0.6	0.9	1.1	1.4
Blench ds =	2.3	2.3	2.3	4.7	
ds (average) =	1.5	1.8	2.0	2.9	1.4

Equation	Nose of pier*		Nose of spur dikes*		Grade control or small dam*
Neill ds =	4.2		2.9		
Lacey ds =			2.0		1.7
Blench ds =	3.8		6.6		4.7
ds (average) =	4.0		3.8		3.2

* Use these for rough calculations only, equations specific to these scour types should be used for more accuracy



Hydraulic Jump

HEC RAS Issues
2/21/98

HEC RAS Plan: Plan 01 River: Silver Bow Reach: a

Reach	River Sta	Q Total (cfs)	Cum Ch Len (ft)	Min Ch El (ft)	W.S. Elev (ft)	Q Channel (cfs)	Hydr Depth (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	W.P. Total (ft)	Flow Area Ch (sq ft)	Top W Chnl (ft)	Shear Chan (lb/sq ft)
a	911.*	440.00	4146.08	5389.24	5394.06	440.00	2.91	0.005983	6.30	69.87	24.01	26.31	69.87	24.01	0.99
a	910.9*	440.00	4136.08	5389.20	5393.99	440.00	2.89	0.006130	6.35	69.26	23.93	26.22	69.26	23.93	1.01
a	910.8*	440.00	4126.08	5389.15	5393.92	440.00	2.89	0.006211	6.38	68.93	23.88	26.16	68.93	23.88	1.02
a	910.7*	440.00	4116.08	5389.11	5393.85	440.00	2.87	0.006401	6.45	68.18	23.77	26.03	68.18	23.77	1.05
a	910.6*	440.00	4106.08	5389.06	5393.78	440.00	2.86	0.006518	6.50	67.72	23.70	25.95	67.72	23.70	1.06
a	910.5*	440.00	4096.08	5389.02	5393.69	440.00	2.83	0.006813	6.60	66.64	23.55	25.76	66.64	23.55	1.10
a	910.4*	440.00	4086.08	5388.98	5393.59	440.00	2.80	0.007194	6.74	65.32	23.35	25.53	65.32	23.35	1.15
a	910.3*	440.00	4076.08	5388.93	5393.49	440.00	2.77	0.007503	6.84	64.31	23.18	25.34	64.31	23.18	1.19
a	910.2*	440.00	4066.08	5388.89	5393.36	440.00	2.73	0.008196	7.07	62.24	22.84	24.96	62.24	22.84	1.28
a	910.1*	440.00	4056.08	5388.84	5393.21	440.00	2.67	0.009103	7.35	59.86	22.42	24.49	59.86	22.42	1.39
a	910	440.00	4046.08	5388.80	5392.90	440.00	2.53	0.011908	8.12	54.18	21.41	23.35	54.18	21.41	1.73
a	858.687*	440.00	4036.08	5388.74	5392.76	440.00	2.45	0.012588	8.22	53.53	21.82	23.61	53.53	21.82	1.78
a	807.375*	440.00	4026.08	5388.67	5392.64	440.00	2.39	0.012850	8.21	53.62	22.42	24.09	53.62	22.42	1.79
a	756.062*	440.00	4016.08	5388.61	5392.48	440.00	2.31	0.013723	8.32	52.85	22.87	24.41	52.85	22.87	1.86
a	704.75*	440.00	4006.08	5388.55	5392.35	440.00	2.25	0.014014	8.31	52.97	23.51	24.93	52.97	23.51	1.86
a	653.437*	440.00	3996.08	5388.49	5392.22	440.00	2.21	0.014093	8.25	53.33	24.14	25.47	53.33	24.14	1.84
a	602.125*	440.00	3986.08	5388.42	5392.13	440.00	2.21	0.013256	8.02	54.89	24.86	26.14	54.89	24.86	1.74
a	550.812*	440.00	3976.08	5388.36	5392.06	440.00	2.23	0.012066	7.71	57.08	25.60	26.86	57.08	25.60	1.60
a	499.5	440.00	3966.08	5388.30	5392.01	440.00	2.26	0.010756	7.36	59.81	26.42	27.70	59.81	26.42	1.45
a	448.187*	440.00	3956.08	5388.24	5391.96	440.00	2.31	0.009347	6.96	63.21	27.40	28.71	63.21	27.33	1.29
a	396.875*	440.00	3946.08	5388.17	5391.94	439.70	1.90	0.007630	6.51	68.18	34.44	35.78	67.52	27.77	1.11
a	345.562*	440.00	3936.08	5388.11	5391.94	437.52	1.97	0.005971	6.04	75.45	38.35	39.71	72.44	27.81	0.93
a	294.25\	440.00	3926.08	5388.05	5391.95	433.41	1.99	0.004636	5.50	84.35	42.38	43.78	77.70	27.85	0.78
a	242.937*	440.00	3916.08	5387.99	5391.96	427.76	1.73	0.003604	5.14	94.90	54.88	56.34	83.15	27.89	0.65
a	191.625*	440.00	3906.08	5387.92	5391.98	419.10	1.39	0.002767	4.71	110.89	79.98	81.52	88.92	27.92	0.53
a	140.312*	440.00	3896.08	5387.86	5392.00	407.06	1.20	0.002109	4.29	133.20	107.92	109.53	94.83	27.96	0.43
a	89	440.00	3886.08	5387.80	5392.02	394.01	1.14	0.001619	3.91	161.71	142.28	143.95	100.74	28.00	0.35
a	88.9568*	440.00	3876.08	5387.76	5391.99	399.16	1.07	0.001705	4.01	156.39	146.07	147.66	99.45	27.66	0.37
a	88.9130*	440.00	3866.08	5387.72	5391.96	402.67	1.03	0.001781	4.10	152.27	148.28	149.81	98.17	27.30	0.39
a	88.8695*	440.00	3856.08	5387.68	5391.93	406.33	1.06	0.001853	4.19	149.90	141.26	142.72	97.05	26.96	0.40
a	88.8260*	440.00	3846.08	5387.64	5391.91	405.71	1.09	0.001806	4.23	148.22	136.02	137.44	95.96	26.61	0.41
a	88.7826*	440.00	3836.08	5387.60	5391.88	404.55	1.12	0.001916	4.26	147.02	131.07	132.45	94.85	26.26	0.42
a	88.7391*	440.00	3826.08	5387.56	5391.86	402.75	1.15	0.001940	4.29	146.55	126.97	128.33	93.78	25.91	0.42

INTER-FLUVE, INC.

25 N. WILLSON AVE.
SUITE 5
BOZEMAN, MT 59715
(406) 586-6926
FAX (406) 586-8445

MEMORANDUM

To: *Silver Bow Creek, SSTOU SubArea 1, Reach A*
From: *Shelly Donner*
Date: *4/7/98*
In Regards To: *Diversion Channel Haul Road Crossings*

Haul Road Crossings

Haul road crossings will be placed to span the diversion channel for use during the construction phase of Reach A. The roads will be 50-feet wide to accommodate trucks and construction equipment, as requested by Maxim. Two 3-foot diameter culverts were chosen for a minimum capacity of 70-cfs. This flow will accommodate the maximum-recorded daily flow of 67-cfs for the anticipated construction season between August and November (Inter-Fluve and MEI, 1998). Two culverts of three foot diameter were chosen in order to fit with in the diversion channel and maintain the two feet of spacing required for pipes under 48 inches in diameter. Using the maximum slope, 1V: 1.5H, for the faces of the road and culvert gives a total culvert length of 68-feet.

The riprap used for cover and fill around the culverts was sized using incipient motion to withstand flows up to 120-cfs. Sizing of the riprap was determined by using the minimum for 70-cfs and a maximum of 120-cfs, giving a range of riprap that will fail at flows exceeding 120-cfs. The resulting riprap sizes allow the use of 4-inch minus crushed road base material grade 1, as specified in Technical Specifications.

The cover over the culverts was originally requested (by Maxim) to be 3-feet, we found that this was excessive, and the required minimum cover is one foot. The one-foot of cover was calculated using a truck weighing up to 100 tons with three axles and two three foot diameter pipes, please see attached calculation sheets. A 2-foot cover, which is to be required as the minimum, over the pipes would provide for excessive load crossings and would reduce the distance from the top of the bank to the height of the road. The values for corrugation and gage were also calculated, giving values of 2x1/2" corrugation and 0.064 for gage. The slope of the diversion channel is to be maintained through the slope of the culvert.

After the useful life of the haul road crossing is complete, all of the crossing materials are to be removed by the contractor. At this location the diversion channel must be ripraped and berms must be returned to correct height, as was specified originally.

L. FOTHERBY

CHECK MIN. COVER FOR TEMPORARY CULVERT CROSSINGS

HS-20 = 36 ton truck-semi trailer combination

Minor Highways std vehicle is trucks weighing 20 ton (H-20)

\# from Highway Eng 1992 Oglesby & Hicks

HS 20-44

9,000 lb | 32,000 lb | 32,000 lb | 72,000 lb = 36 ton

.2W | .8W | .8W

Where W = Wt on front two axles

H 20 = 20 ton = 40,000 lb

.2W + .8W + .8W = 40,000

1.8W = 40,000

W = 22,222 lb

.8W = 17,777 or 18,000 lbs

But Maxim requested consideration of trucks weighing up to 100 tons w/ 3 axles

100 ton = 200,000 lbs = 1.8W

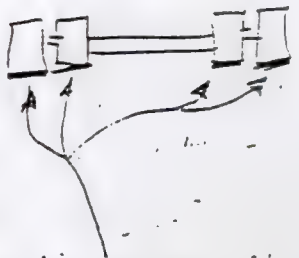
W = 111,111

.8W = 88,888 = 89,000 lbs

Distributed over 4 tires Area = ?

From Fig 3-3 of Handbook of Steel Drainage 1979, pg 86.

"Live load Applied on Assumed Area of 36" x 40" "



3' x 3.33' = 10 ft² TOTAL AREA

FROM HANDBOOK STEEL DRAINAGE, 1971

Height of Cover < Dia. of Pipe ∴ use "total load is assumed to act on pipe". $T_L = P_v$

T_{rg} 89,000 lb × $\frac{\quad}{10\ ft^2}$ = 8,900 lbs/ft²

$P_t = (DL + LL)$, when $H < S$ (H = Ht. of Cover = Assume 1 ft
S = Span = 34')

DL = 1 ft deep soil ≈ 120 lbs/ft² = So Many Live Loads

CHECK ALTERNATIVE LOADING
MAXIMUMS FOR TANDEM AXLES (HIGHWAY ENG. 4TH ED. OGLESBY · HICKS)

AASHTO STATE

34,000 40,000 lbs

40,000 lbs × $\frac{\quad}{10\ ft^2}$ = 4,000 lb/ft² < 8,900 lb/ft²

RING COMPRESSION

$C = P_v \times \frac{S}{2}$ = 9,900 $\frac{lb}{ft^2}$ × $\frac{34'}{2}$ = 13,350 lb/ft

ALLOWABLE WALL STRESS

1. $f_b = f_y$ = 33,000 psi when $\frac{D}{r} < 294$ 36" = D
for 68 in. 2 2/3 × 1/2 in corrugation
r = .172"

$\frac{36}{.172} = 209$ ✓

2. $f_c = \frac{f_b}{2} = \frac{33,000\ psi}{2} = 16,500$ psi

WALL THICKNESS

$A = \frac{C}{f_c} = 13,350\ lb/ft \times \frac{\quad}{16,500\ lb}\ in^2 = .809\ in^2/ft$

From Handbook of Steel Drainage; Table 1-3, pg 41

Can use a 1½" x ¼ in Corrugation

For A = .8091, Specified gage thickness = .079 for

A = .950 > .8091 in^2/ft width.

Min gage = .079 in for 1½ x ¼" corrugations

r = 0.090

radius of gyration - go back and check f_b

$\frac{D}{r} = \frac{36"}{.09} = 450 > 294$ Not Good - need new eq - Eq 8-

$\therefore f_b = 40{,}000 - .091\left(\frac{D}{r}\right)^2$, when $D/r > 294$ and < 500.

$40{,}000 - .091(450)^2 = 23{,}598.163$ psi

$f_c = \frac{f_b}{2} = 11{,}799$ psi

Wall Thickness

$A = \frac{C}{f_c} = \frac{13{,}350\ lb/ft}{11{,}799\ lb/in^2} = 1.131\ in^2/ft$ width

Could use non-standard gage = 0.109 for 1½ x ¼ in corrugations

or Standard 0.109 gage for 2 x ½" corrugations (A = 1.429 in²/ft)

Check r = 0.17

$\frac{D}{r} = \frac{36}{.17} = 212 < 294$ not >

So conservative

Use original equation

$f_b = f_y = 33{,}000$ psi when $\frac{D}{t} < 294$

$f_c = \frac{f_b}{2} = 16{,}500$ psi

$A = \frac{P}{f_c} = \frac{13{,}350}{16{,}500 \text{ psi}} = 0.809$ in² Can't use 1½ x ¼" corr.

So use

2 x ½" Corr., A = .815 for .064 gage

3 ft Dia Pipe

3' DIA PIPE
2 x ½" Corrugations
GAGE = 0.064
@ 1FT COVER

22-141 50 SHEETS
22-142 100 SHEETS
22-144 200 SHEETS

Project: Silver Bow (haul road crossing over ditch) Q=70 CFS
Name: Shelly Donner
Date: 26-Feb-98

Needed for method:	Parameter					units	Generally assumed to be
12	Shield's Paramter				0.03		0.047
	Hydraulic Radius				1.73	ft	
2	Shear Stress				0.14	lb/ft^2	
1	Depth (channel average				2	ft	
4	Depth (local)				2.76	ft	
1234	Specific Gravity of Rock Riprap				2.65		2.65
123	Unit Weight of Sediment				165.4	lb/ft^3	165.4
1234	Unit Weight of Water				62.4	lb/ft^3	62.4
1234	Slope Angle (side slope with horizontal				33.7	degrees	
1234	Angle of Repose				38	degrees	
1	Energy Gradient				0.00129	ft/ft	
34	Velocity (average)				2.2	ft/sec	
4	Bend Radius of Curvature				1000	ft	
4	Width of Water Surface				20.89	ft	
4	Enter 1 if trapezoidal channel, 2 if natura				1		
4	Enter 1 if straight channel or outside bend with r/w>2				1		
	or enter 2 if outside bend with r/w<2						
1234	Gravitational Constan				32.2	ft/sec^2	32.2
4	Stability Coefficient	(0.3 for angular rock and 0.36 for round			0.36		
124	Safety Factor				1.5		

Output		ft	inches	mm	# of paramters	Check
1. FHWA Energy Slope Method	D50	0.18	2.16	54.99	10	Data OK
2. FHWA Shear Method	D50	0.16	1.88	47.80	9	Data OK
3. Isbash Velocity Method	D50	0.04	0.46	11.58	7	Data OK
4. ACOE (seen note below)	D30	0.01	0.07	1.83	13	Data OK
5. Basic Shields Relation for incipient motion	D50	0.05	0.54	13.81	5	Data OK

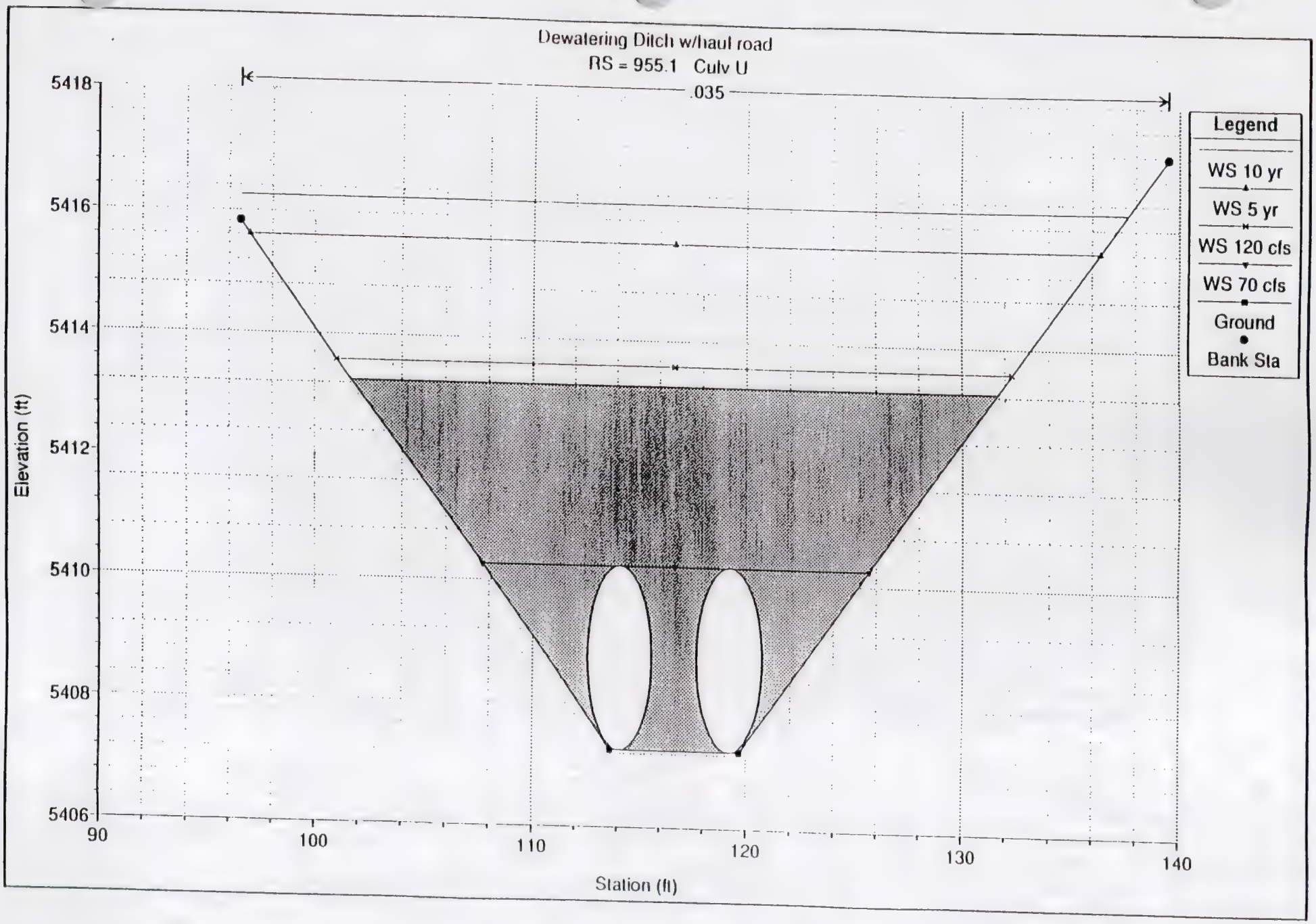
The ACOE approach is extremely sensative to velocity.

Project: Silver Bow (haul road crossing over ditch) Q=120 CFS
Name: Shelly Donner
Date: 26-Feb-98

Needed for method:	Parameter		units	Generally assumed to be
12	Shield's Paramter	0.03		0.047
	Hydraulic Radius	1.96	ft	
2	Shear Stress	0.25	lb/ft^2	
1	Depth (channel average	2.6	ft	
4	Depth (local)	3.21	ft	
1234	Specific Gravity of Rock Riprap	2.65		2.65
123	Unit Weight of Sediment	165.4	lb/ft^3	165.4
1234	Unit Weight of Water	62.4	lb/ft^3	62.4
1234	Slope Angle (side slope with horizonta	33.7	degrees	
1234	Angle of Repose	38	degrees	
1	Energy Gradien	0.002046	ft/ft	
34	Velocity (average	3.01	ft/sec	
4	Bend Radius of Curvature	1000	ft	
4	Width of Water Surface	18.85	ft	
4	Enter 1 if trapezoidal channel, 2 if natur	1		
4	Enter 1 if straight channel or outside bend with r/w>2 or enter 2 if outside bend with r/w<2	1		
1234	Gravitational Constan	32.2	ft/sec^2	32.2
4	Stability Coefficient (0.3 for angular rock and 0.36 for round	0.36		
124	Safety Factor	1.5		

Output		ft	inches	mm	# of paramters	Check
1. FHWA Energy Slope Method	D50	0.37	4.46	113.38	10	Data OK
2. FHWA Shear Method	D50	0.28	3.36	85.36	9	Data OK
3. Isbash Velocity Method	D50	0.07	0.85	21.68	7	Data OK
4. ACOE (seen note below)	D30	0.01	0.12	3.08	13	Data OK
5. Basic Shields Relation for incipient motion	D50	0.08	0.97	24.66	5	Data OK

The ACOE approach is extremely sensative to velocity.


Dewatering Ditch w/haul road
RS = 955.1 Culv U
.035
Legend
WS 10 yr
WS 5 yr
WS 120 cfs
WS 70 cfs
Ground
Bank Sta
Elevation (ft)
5418
5416
5414
5412
5410
5408
5406
90
100
110
120
130
140
Station (ft)

Diversion Channel Hec-ras Model: Input Parameters

Inter-fluve, Inc. 4/9/98

Hec-Ras hydraulic modeling was used extensively in the design of the diversion channel and diversion structure. The diversion channel model was based on the reconstructed channel (Reach A) model, with the segment of reconstructed channel from station 12+00 to 73+00 being replaced by the diversion ditch (D0+00 - D58+60). Geometric input included the following.

Diversion channel roughness:	0.035
Channel slope:	0.0012-0.0049
County road culvert	
Size:	7'7" x 11'10"
Slope:	0.004
Roughness:	0.028
Entrance loss coefficient:	0.5
Exit loss coefficient:	1.0

Model discharges were determined using an iterative method described in Appendix C, Section C-1. This method balanced three flows (those of the diversion channel, the spillway, and the diversion structure culverts) until a total discharge was achieved that closely approximated the 2-, 5-, 10-, 20-, and 50-yr Silver Bow Creek discharges. The resulting apportionment of flows at the diversion structure is presented in the following table.

Silver Bow Creek Flow (cfs)	Aproximate return period (yr)	Culvert discharge (cfs)	Spillway discharge (cfs)	Diversion channel discharge (cfs)	Diversion channel model discharge (cfs)		
					Above Hec sta 957.8 (D1+46)	Hec sta 957.8 - 957.5 (D1+66)	Below Hec sta 957.5
0-35	-	all	-	-	-	-	-
229	2	69	-	160	160	160	160
446	5	86	-	360	360	360	360
647	10	97	-	550	550	550	550
790	20	103	27	660	687	674	660
1045	50	110	135	800	935	867	800

The model was run in the mixed (sub- and supercritical analysis) mode. At the upstream end of Reach A, the Normal Depth boundary condition was used. There was no other information available about the upstream hydraulic conditions, therefore the upstream normal depth slope entering Reach A was estimated to be 0.0034. This was based on the channel bed slope of Lower Area One (LAO), and the fact that channel bed slope is often an accurate approximation of the water surface profiles during higher flows. In order to

accurately model the downstream end of the proposed channel conditions, the proposed channel model was tied into the existing channel model at end of the construction reach (HEC station 901). The existing channel model was extended ~4100 ft downstream in order to negate any effect of downstream boundary conditions. The Downstream Normal Depth boundary condition was set at S=0.0034.

Output from the diversion structure Hec-ras model, run at the discharges shown above, is presented in the following pages. Since Hec-ras stationing differed from the diversion channel stationing shown on the Plans, both station identifiers are given for each cross-section.

Silver Bow Creek SSTOU, Reach A Diversion Channel Design, 229 cfs

Ditch Station	HEC XS	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
0	959	229	343.62	5413.27	4.72	0.02	146.78	1.04
32	958	229	48.62	5412.9	1.9	0.7	36.31	4.71
100	957.9	229	43.03	5412.24	2.21	0.82	23.86	5.32
146	957.8	160	43.99	5412.17	2.25	0.38	24.02	3.64
166	957.5	160	43.4	5412.09	2.23	0.39	23.92	3.69
172	955.5	160	45.03	5412.08	2.23	0.37	25.4	3.55
176	955.466*	160	45.54	5412.07	2.62	0.35	22.79	3.51
180	955.433*	160	43.06	5412.03	2.98	0.38	19.9	3.72
184	955.4	160	37.23	5411.94	3.29	0.51	16.66	4.3
236	955.3	160	35.01	5411.67	3.15	0.58	16.22	4.57
300	955.2	160	37.89	5411.43	3.33	0.49	16.79	4.22
375	955.15*	160	43.02	5411.22	3.39	0.37	18.89	3.72
450	955.1*	160	45.09	5411.03	3.48	0.34	19.92	3.55
525	955.05*	160	47.27	5410.86	3.59	0.31	20.35	3.38
600	955	160	49.78	5410.71	3.71	0.28	20.84	3.21
698	953.75*	160	51.19	5410.53	3.78	0.26	21.11	3.13
796	952.5*	160	52.98	5410.36	3.86	0.24	21.44	3.02
894	951.25*	160	55.18	5410.21	3.96	0.22	21.85	2.9
992	950	160	57.81	5410.08	4.08	0.2	22.33	2.77
1092	947.5*	160	57.48	5409.95	4.07	0.2	22.27	2.78
1192	945.*	160	57.31	5409.81	4.06	0.2	22.24	2.79
1292	942.5*	160	56.88	5409.67	4.04	0.21	22.16	2.81
1392	940	160	56.6	5409.53	4.03	0.21	22.11	2.83
1492	939.5*	160	55.47	5409.38	4	0.22	21.75	2.88
1592	939.*	160	54.43	5409.22	3.97	0.23	21.42	2.94
1692	938.5*	160	53.01	5409.05	3.92	0.24	21.03	3.02
1792	938	160	51.53	5408.87	3.87	0.25	20.62	3.1
1892	937.75*	160	49.2	5408.67	3.79	0.28	20.24	3.25
1992	937.5*	160	46.4	5408.42	3.67	0.32	19.75	3.45
2092	937.25*	160	42.17	5408.11	3.48	0.39	18.97	3.79
2192	937	160	34.81	5407.6	3.1	0.6	17.42	4.6
2278	936.2*	160	34.87	5407.16	3.08	0.59	17.44	4.59
2364	935.4*	160	35.38	5406.73	3.08	0.58	17.56	4.52
2450	934.6*	160	36.1	5406.33	3.1	0.55	17.72	4.43
2536	933.8*	160	37.85	5405.97	3.17	0.5	18.11	4.23
2622	933	160	40.61	5405.67	3.29	0.43	18.69	3.94
a	932.4	Culvert						
2692.1	932	160	40.26	5405.04	3.05	0.44	20.37	3.97
2792.1	931.6*	160	40.03	5404.66	3.11	0.45	19.95	4
2892.1	931.2*	160	39.79	5404.27	3.17	0.45	19.55	4.02
2992.1	930.8*	160	39.19	5403.88	3.2	0.47	19.08	4.08
3092.1	930.4*	160	38.48	5403.47	3.23	0.48	18.6	4.16
3192.1	930	160	37.21	5403.04	3.24	0.52	18	4.3
3292.1	928.*	160	37.17	5402.6	3.24	0.52	17.94	4.3
3392.1	926.*	160	37.13	5402.17	3.25	0.52	17.87	4.31
3492.1	924.*	160	37.08	5401.73	3.25	0.52	17.81	4.32
3592.1	922.*	160	37.01	5401.3	3.26	0.52	17.74	4.32
3692.1	920	160	36.91	5400.86	3.26	0.52	17.66	4.33
3792.1	919.6*	160	36.88	5400.42	3.26	0.52	17.63	4.34
3892.1	919.2*	160	36.82	5399.98	3.26	0.53	17.59	4.34
3992.1	918.8*	160	36.74	5399.54	3.26	0.53	17.55	4.35
4092.1	918.4*	160	36.55	5399.09	3.25	0.53	17.48	4.38
4192.1	918	160	36.1	5398.63	3.23	0.55	17.36	4.43
4292.1	917.6*	160	36.96	5398.19	3.23	0.52	17.68	4.33
4392.1	917.2*	160	38.6	5397.8	3.28	0.48	18.16	4.14
4492.1	916.8*	160	41.53	5397.47	3.39	0.41	18.92	3.85
4592.1	916.4*	160	46.18	5397.22	3.58	0.32	20	3.46
4692.1	916	160	35.38	5396.74	3.54	0.58	17.5	4.52
5192.1	915	160	35.31	5394.27	3.27	0.57	16.57	4.53
5592.1	911	160	32.18	5392.45	2.95	0.71	16.81	4.97
5692.1	910	160	69.07	5390.79	2.55	0.4	57.56	3.54
5853.1	89	160	60.44	5390.51	2.71	0.2	39.17	2.73
6083.1	88	160	45.43	5389.94	3.04	0.35	25.08	3.58
6255.1	87	160	49.68	5389.51	2.61	0.29	25.16	3.22

Silver Bow Creek SSTOU, Reach A Diversion Channel Design, 446 cfs

Ditch Station	HEC XS	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
0	959	446	513.96	5414.39	5.84	0.02	157.3	1.09
32	958	446	105.7	5414.2	3.2	0.32	51.02	3.41
100	957.9	446	89.95	5413.96	3.93	0.4	30.73	4
146	957.8	360	90.46	5413.86	3.95	0.39	30.8	3.98
166	957.5	360	90.63	5413.82	3.96	0.39	30.82	3.97
172	955.5	360	96.38	5413.82	3.97	0.35	33.53	3.74
176	955.466*	360	90.64	5413.78	4.33	0.39	29.85	3.97
180	955.433*	360	81.62	5413.71	4.66	0.47	26.04	4.41
184	955.4	360	68.47	5413.56	4.91	0.68	21.91	5.26
236	955.3	360	65.9	5413.3	4.79	0.74	21.53	5.46
300	955.2	360	70.21	5413.08	4.98	0.65	22.17	5.13
375	955.15*	360	79.66	5412.91	5.08	0.49	24.38	4.52
450	955.1*	360	85.32	5412.75	5.21	0.43	26.55	4.22
525	955.05*	360	88.87	5412.6	5.33	0.4	27.33	4.05
600	955	360	92.55	5412.47	5.47	0.36	27.86	3.89
698	953.75*	360	94.66	5412.29	5.54	0.34	28.16	3.8
796	952.5*	360	97.18	5412.13	5.63	0.33	28.52	3.7
894	951.25*	360	100.11	5411.98	5.73	0.31	28.93	3.6
992	950	360	103.42	5411.85	5.85	0.28	29.38	3.48
1092	947.5*	360	102.71	5411.7	5.82	0.29	29.29	3.5
1192	945.*	360	102.17	5411.55	5.8	0.29	29.21	3.52
1292	942.5*	360	101.33	5411.4	5.77	0.3	29.1	3.55
1392	940	360	100.6	5411.25	5.75	0.3	29	3.58
1492	939.5*	360	98.28	5411.08	5.7	0.32	28.47	3.66
1592	939.*	360	96.02	5410.9	5.65	0.33	27.96	3.75
1692	938.5*	360	93.24	5410.71	5.58	0.35	27.4	3.86
1792	938	360	90.28	5410.51	5.51	0.38	26.8	3.99
1892	937.75*	360	86.65	5410.27	5.39	0.42	26.39	4.15
1992	937.5*	360	82.37	5410	5.25	0.46	25.87	4.37
2092	937.25*	360	76.31	5409.66	5.03	0.55	25.07	4.72
2192	937	360	67.17	5409.18	4.68	0.72	23.71	5.36
2278	936.2*	360	69.59	5408.83	4.75	0.67	24.08	5.17
2364	935.4*	360	73.57	5408.54	4.89	0.59	24.69	4.89
2450	934.6*	360	78.7	5408.3	5.07	0.51	25.45	4.57
2536	933.8*	360	85.64	5408.11	5.31	0.43	26.45	4.2
2622	933	360	93.73	5407.97	5.59	0.35	27.55	3.84
a	932.4	Culvert						
2692.1	932	360	74.94	5406.5	4.51	0.58	27.23	4.8
2792.1	931.6*	360	74.33	5406.13	4.58	0.59	26.65	4.84
2892.1	931.2*	360	73.61	5405.76	4.65	0.6	26.08	4.89
2992.1	930.8*	360	72.3	5405.37	4.69	0.62	25.44	4.98
3092.1	930.4*	360	70.74	5404.96	4.72	0.65	24.77	5.09
3192.1	930	360	68.31	5404.52	4.72	0.7	23.96	5.27
3292.1	928.*	360	68.22	5404.09	4.73	0.7	23.87	5.28
3392.1	926.*	360	68.11	5403.65	4.73	0.7	23.77	5.29
3492.1	924.*	360	67.98	5403.22	4.74	0.7	23.68	5.3
3592.1	922.*	360	67.8	5402.79	4.75	0.71	23.57	5.31
3692.1	920	360	67.56	5402.35	4.75	0.71	23.46	5.33
3792.1	919.6*	360	67.47	5401.91	4.75	0.72	23.41	5.34
3892.1	919.2*	360	67.34	5401.47	4.75	0.72	23.35	5.35
3992.1	918.8*	360	67.18	5401.03	4.75	0.72	23.29	5.36
4092.1	918.4*	360	66.91	5400.58	4.74	0.73	23.21	5.38
4192.1	918	360	66.42	5400.13	4.73	0.74	23.09	5.42
4292.1	917.6*	360	68.16	5399.71	4.75	0.7	23.52	5.28
4392.1	917.2*	360	70.96	5399.33	4.81	0.64	24.13	5.07
4492.1	916.8*	360	75.17	5399	4.92	0.57	24.95	4.79
4592.1	916.4*	360	81.13	5398.74	5.1	0.48	26.02	4.44
4692.1	916	360	65.7	5398.21	5.01	0.76	23.74	5.48
5192.1	915	360	63.25	5395.73	4.73	0.81	21.73	5.69
5592.1	911	360	57.83	5393.77	4.27	1	22.08	6.23
5692.1	910	360	151.91	5391.97	3.73	0.36	78.05	3.62
5853.1	89	360	119.16	5391.64	3.84	0.33	88.41	3.73
6083.1	88	360	98.25	5390.94	4.04	0.62	80.32	5.07
6255.1	87	360	118	5390.49	3.59	0.46	101.22	4.29

Silver Bow Creek SSTOU, Reach A Diversion Channel Design, 647 cfs

Ditch Station	HEC XS	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
0	959	647	720.88	5415.65	7.1	0.04	171.85	1.4
32	958	647	177.24	5415.44	4.44	0.33	64.9	3.65
100	957.9	647	125.65	5415.05	5.02	0.61	35.07	5.15
146	957.8	550	129.16	5415.03	5.12	0.42	35.47	4.26
166	957.5	550	129.58	5414.99	5.13	0.41	35.52	4.24
172	955.5	550	139.3	5415	5.15	0.36	39.05	3.95
176	955.466*	550	128.29	5414.95	5.5	0.42	34.66	4.29
180	955.433*	550	113.87	5414.86	5.81	0.54	30.23	4.83
184	955.4	550	94.8	5414.67	6.02	0.78	25.51	5.8
236	955.3	550	92.09	5414.42	5.91	0.84	25.17	5.97
300	955.2	550	97.47	5414.22	6.12	0.74	25.85	5.64
375	955.15*	550	109.91	5414.07	6.24	0.57	28.12	5
450	955.1*	550	118.75	5413.93	6.38	0.49	30.46	4.63
525	955.05*	550	124.03	5413.79	6.52	0.45	32.07	4.43
600	955	550	128.55	5413.66	6.66	0.41	32.63	4.28
698	953.75*	550	131.23	5413.49	6.74	0.4	32.95	4.19
796	952.5*	550	134.33	5413.33	6.83	0.38	33.33	4.09
894	951.25*	550	137.84	5413.19	6.94	0.36	33.75	3.99
992	950	550	141.72	5413.05	7.05	0.34	34.2	3.88
1092	947.5*	550	140.88	5412.9	7.02	0.34	34.11	3.9
1192	945.*	550	140.25	5412.76	7.01	0.34	34.03	3.92
1292	942.5*	550	139.24	5412.61	6.98	0.35	33.92	3.95
1392	940	550	138.41	5412.45	6.95	0.35	33.81	3.97
1492	939.5*	550	135.43	5412.29	6.91	0.37	33.22	4.06
1592	939.*	550	132.55	5412.11	6.86	0.39	32.64	4.15
1692	938.5*	550	129.12	5411.92	6.79	0.41	32.03	4.26
1792	938	550	125.53	5411.72	6.72	0.43	31.38	4.38
1892	937.75*	550	121.86	5411.5	6.62	0.46	31.08	4.51
1992	937.5*	550	117.81	5411.25	6.5	0.5	30.73	4.67
2092	937.25*	550	112.57	5410.97	6.34	0.55	30.24	4.89
2192	937	550	106.1	5410.64	6.14	0.63	29.56	5.18
2278	936.2*	550	113.24	5410.43	6.35	0.54	30.44	4.86
2364	935.4*	550	122.23	5410.27	6.62	0.46	31.52	4.5
2450	934.6*	550	132.25	5410.14	6.91	0.39	32.67	4.16
2536	933.8*	550	143.91	5410.04	7.24	0.32	33.68	3.82
2622	933	550	155.77	5409.96	7.58	0.27	33	3.53
a	932.4	Culvert						
2692.1	932	550	103.97	5407.48	5.49	0.67	31.86	5.29
2792.1	931.6*	550	102.92	5407.12	5.57	0.68	31.15	5.34
2892.1	931.2*	550	101.7	5406.75	5.64	0.7	30.46	5.41
2992.1	930.8*	550	99.75	5406.36	5.68	0.72	29.7	5.51
3092.1	930.4*	550	97.38	5405.96	5.71	0.76	28.88	5.65
3192.1	930	550	93.98	5405.51	5.71	0.82	27.93	5.85
3292.1	928.*	550	93.82	5405.08	5.72	0.82	27.82	5.86
3392.1	926.*	550	93.65	5404.65	5.73	0.82	27.71	5.87
3492.1	924.*	550	93.44	5404.21	5.73	0.82	27.59	5.89
3592.1	922.*	550	93.16	5403.78	5.74	0.83	27.46	5.9
3692.1	920	550	92.79	5403.34	5.74	0.84	27.32	5.93
3792.1	919.6*	550	92.67	5402.9	5.74	0.84	27.26	5.94
3892.1	919.2*	550	92.5	5402.47	5.75	0.84	27.2	5.95
3992.1	918.8*	550	92.28	5402.02	5.75	0.85	27.12	5.96
4092.1	918.4*	550	91.96	5401.58	5.74	0.85	27.04	5.98
4192.1	918	550	91.42	5401.13	5.73	0.86	26.92	6.02
4292.1	917.6*	550	93.79	5400.71	5.75	0.82	27.41	5.86
4392.1	917.2*	550	97.33	5400.34	5.82	0.75	28.06	5.65
4492.1	916.8*	550	102.39	5400.01	5.93	0.68	28.92	5.37
4592.1	916.4*	550	109.22	5399.74	6.1	0.59	30	5.04
4692.1	916	550	91.07	5399.19	5.99	0.88	27.9	6.04
5192.1	915	550	85.71	5396.69	5.69	0.98	25.12	6.42
5592.1	911	550	78.89	5394.65	5.15	1.19	25.61	6.97
5692.1	910	550	203.32	5392.61	4.37	0.43	84.35	4.08
5853.1	89	550	192.29	5392.21	4.41	0.46	167.64	4.53
6083.1	88	550	174.1	5391.53	4.63	0.72	158.26	5.6
6255.1	87	550	184.13	5391.12	4.22	0.51	109.78	4.67

Silver Bow Creek SSTOU, Reach A Diversion Channel Design, 790 cfs

Ditch Station	HEC XS	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
0	959	700	809.9	5416.16	7.61	0.03	177.74	1.35
32	958	700	215.04	5415.99	4.99	0.26	71.15	3.26
100	957.9	700	148.5	5415.68	5.65	0.5	37.59	4.71
146	957.8	680	150.12	5415.6	5.69	0.46	37.76	4.53
166	957.5	660	151.13	5415.58	5.72	0.43	37.87	4.37
172	955.5	660	163.19	5415.6	5.75	0.37	41.81	4.04
176	955.466*	660	149.25	5415.53	6.08	0.44	37.07	4.42
180	955.433*	660	131.88	5415.43	6.38	0.56	32.33	5
184	955.4	660	109.63	5415.23	6.58	0.82	27.33	6.02
236	955.3	660	106.97	5415	6.48	0.87	27.02	6.17
300	955.2	660	113.03	5414.8	6.7	0.77	27.73	5.84
375	955.15*	660	127.08	5414.66	6.83	0.6	30.03	5.19
450	955.1*	660	137.62	5414.53	6.98	0.51	32.41	4.8
525	955.05*	660	144.29	5414.4	7.13	0.46	34.36	4.57
600	955	660	149.4	5414.27	7.27	0.43	35.09	4.42
698	953.75*	660	152.52	5414.11	7.36	0.41	35.44	4.33
796	952.5*	660	156.1	5413.96	7.46	0.39	35.84	4.23
894	951.25*	660	160.09	5413.82	7.57	0.37	36.29	4.12
992	950	660	164.45	5413.69	7.69	0.35	36.76	4.01
1092	947.5*	660	163.77	5413.55	7.67	0.35	36.7	4.03
1192	945.*	660	163.32	5413.41	7.66	0.35	36.64	4.04
1292	942.5*	660	162.54	5413.27	7.64	0.36	36.56	4.06
1392	940	660	161.94	5413.12	7.62	0.36	36.49	4.08
1492	939.5*	660	158.91	5412.97	7.59	0.38	35.9	4.15
1592	939.*	660	156.05	5412.8	7.55	0.39	35.33	4.23
1692	938.5*	660	152.72	5412.63	7.5	0.41	34.74	4.32
1792	938	660	149.34	5412.44	7.44	0.43	34.12	4.42
1892	937.75*	660	146.43	5412.25	7.37	0.45	33.97	4.51
1992	937.5*	660	143.44	5412.05	7.3	0.47	33.81	4.6
2092	937.25*	660	139.76	5411.83	7.2	0.5	33.59	4.72
2192	937	660	135.77	5411.58	7.08	0.53	33.33	4.86
2278	936.2*	660	145.86	5411.44	7.36	0.45	34.44	4.52
2364	935.4*	660	157.56	5411.33	7.68	0.38	34.95	4.19
2450	934.6*	660	169.76	5411.24	8.01	0.32	35.41	3.89
2536	933.8*	660	182.63	5411.17	8.37	0.27	34.6	3.61
2622	933	660	193.51	5411.11	8.73	0.24	33	3.41
a	932.4	Culvert			0			
2692.1	932	660	119.77	5407.96	5.97	0.71	34.11	5.51
2792.1	931.6*	660	118.45	5407.6	6.05	0.72	33.35	5.57
2892.1	931.2*	660	116.9	5407.23	6.12	0.74	32.58	5.65
2992.1	930.8*	660	114.59	5406.85	6.17	0.77	31.76	5.76
3092.1	930.4*	660	111.78	5406.44	6.2	0.81	30.88	5.9
3192.1	930	660	107.79	5405.99	6.19	0.87	29.85	6.12
3292.1	928.*	660	107.65	5405.56	6.2	0.87	29.74	6.13
3392.1	926.*	660	107.43	5405.13	6.21	0.88	29.61	6.14
3492.1	924.*	660	107.16	5404.7	6.22	0.88	29.48	6.16
3592.1	922.*	660	106.83	5404.26	6.22	0.89	29.34	6.18
3692.1	920	660	106.39	5403.82	6.22	0.9	29.19	6.2
3792.1	919.6*	660	106.26	5403.39	6.23	0.9	29.13	6.21
3892.1	919.2*	660	106.08	5402.95	6.23	0.9	29.06	6.22
3992.1	918.8*	660	105.83	5402.51	6.23	0.9	28.98	6.24
4092.1	918.4*	660	105.46	5402.06	6.22	0.91	28.89	6.26
4192.1	918	660	104.88	5401.61	6.21	0.92	28.77	6.29
4292.1	917.6*	660	107.58	5401.2	6.24	0.87	29.29	6.14
4392.1	917.2*	660	111.5	5400.83	6.31	0.81	29.96	5.92
4492.1	916.8*	660	116.93	5400.5	6.42	0.73	30.83	5.64
4592.1	916.4*	660	124.18	5400.23	6.59	0.64	31.91	5.31
4692.1	916	660	104.88	5399.67	6.47	0.93	29.93	6.29
5192.1	915	660	97.69	5397.15	6.15	1.07	26.76	6.76
5592.1	911	660	90.95	5395.1	5.6	1.27	29.66	7.28
5692.1	910	660	223.78	5392.84	4.04	0.53	93.52	4.62
5853.1	89	660	232.3	5392.45	4.65	0.51	171.63	4.79
6083.1	88	660	221.79	5391.82	4.92	0.71	168.93	5.66
6255.1	87	660	216.81	5391.41	4.51	0.55	118.64	4.9

Silver Bow Creek SSTOU, Reach A Diversion Channel Design, 1045 cfs

Ditch Station	HEC XS	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
0	959	935	949.18	5416.93	5409	0.04	186.58	1.55
32	958	935	271.37	5416.74	5411	0.28	79.56	3.45
100	957.9	935	173.77	5416.33	5410	0.63	40.19	5.38
146	957.8	867	176.47	5416.27	5410	0.52	40.46	4.91
166	957.5	800	178.81	5416.28	5410	0.43	40.69	4.47
172	955.5	800	193.53	5416.3	5410	0.37	43	4.13
176	955.466*	800	176.15	5416.24	5409	0.44	38.66	4.54
180	955.433*	800	155.26	5416.13	5409	0.58	34.34	5.15
184	955.4	800	129.2	5415.92	5409	0.85	29.56	6.19
236	955.3	800	126.9	5415.7	5409	0.88	29.31	6.3
300	955.2	800	133.99	5415.53	5408	0.78	30	5.97
375	955.15*	800	150.26	5415.4	5408	0.61	32.44	5.32
450	955.1*	800	163.11	5415.28	5408	0.52	34.87	4.9
525	955.05*	800	171.98	5415.17	5407	0.46	37.16	4.65
600	955	800	178.27	5415.06	5407	0.43	38.24	4.49
698	953.75*	800	182.27	5414.91	5407	0.41	38.65	4.39
796	952.5*	800	186.75	5414.78	5407	0.39	39.12	4.28
894	951.25*	800	191.67	5414.65	5406	0.37	39.62	4.17
992	950	800	196.91	5414.54	5406	0.35	39.67	4.06
1092	947.5*	800	196.82	5414.41	5406	0.35	39.62	4.06
1192	945.*	800	196.98	5414.29	5406	0.35	39.58	4.06
1292	942.5*	800	196.91	5414.17	5406	0.35	39.53	4.06
1392	940	800	197.08	5414.04	5406	0.35	39.48	4.06
1492	939.5*	800	194.56	5413.91	5405	0.36	39.37	4.11
1592	939.*	800	192.23	5413.77	5405	0.36	39.1	4.16
1692	938.5*	800	189.56	5413.63	5405	0.38	38.59	4.22
1792	938	800	186.97	5413.49	5405	0.39	38.06	4.28
1892	937.75*	800	185.71	5413.34	5405	0.39	38.14	4.31
1992	937.5*	800	184.72	5413.19	5405	0.4	37.89	4.33
2092	937.25*	800	183.31	5413.04	5405	0.4	37.34	4.36
2192	937	800	182	5412.89	5405	0.41	36.78	4.4
2278	936.2*	800	194.76	5412.8	5404	0.35	37.24	4.11
2364	935.4*	800	208.6	5412.73	5404	0.3	37.76	3.84
2450	934.6*	800	221.5	5412.67	5403	0.26	36.2	3.61
2536	933.8*	800	232.9	5412.62	5403	0.23	34.6	3.43
2622	933	800	241.88	5412.57	5402	0.21	33	3.31
a	932.4	Culvert						
2692.1	932	800	139.11	5408.51	5402	0.75	36.69	5.75
2792.1	931.6*	800	137.45	5408.15	5402	0.77	35.85	5.82
2892.1	931.2*	800	135.54	5407.78	5401	0.79	35.01	5.9
2992.1	930.8*	800	132.75	5407.4	5401	0.82	34.12	6.03
3092.1	930.4*	800	129.3	5406.98	5400	0.87	33.15	6.19
3192.1	930	800	124.64	5406.53	5400	0.94	32.04	6.42
3292.1	928.*	800	124.45	5406.1	5399	0.94	31.91	6.43
3392.1	926.*	800	124.22	5405.67	5399	0.94	31.78	6.44
3492.1	924.*	800	123.89	5405.24	5398	0.95	31.64	6.46
3592.1	922.*	800	123.47	5404.81	5398	0.95	31.48	6.48
3692.1	920	800	122.92	5404.37	5398	0.96	31.32	6.51
3792.1	919.6*	800	122.74	5403.93	5397	0.96	31.25	6.52
3892.1	919.2*	800	122.51	5403.49	5397	0.97	31.17	6.53
3992.1	918.8*	800	122.22	5403.05	5396	0.97	31.09	6.55
4092.1	918.4*	800	121.82	5402.61	5396	0.98	30.99	6.57
4192.1	918	800	121.17	5402.16	5395	0.99	30.86	6.6
4292.1	917.6*	800	124.2	5401.75	5395	0.94	31.4	6.44
4392.1	917.2*	800	128.52	5401.37	5395	0.87	32.1	6.22
4492.1	916.8*	800	134.39	5401.05	5394	0.79	32.85	5.95
4592.1	916.4*	800	142.11	5400.77	5394	0.7	33.62	5.63
4692.1	916	800	121.67	5400.21	5393	0.99	32.22	6.58
5192.1	915	800	110.58	5397.62	5391	1.2	28.41	7.23
5592.1	911	800	108.94	5395.58	5390	1.34	41.21	7.66
5692.1	910	800	248.31	5393.07	5389	0.87	135.25	5.99
5853.1	89	800	279.09	5392.72	5388	0.55	176.19	5.06
6083.1	88	800	276.98	5392.13	5387	0.72	180.49	5.76
6255.1	87	800	253.15	5391.7	5387	0.6	127.77	5.22

APPENDIX C-3

Upstream Reach A Dewatering

INTER-FLUVE, INC.

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MEMORANDUM

To: ***Silver Bow Creek SSTOU, SubArea 1, Reach A***
From: ***Martin Doyle***
Date: ***4/7/98***
In Regards To: Upstream Reach A Dewatering System

Due to the confined nature of the floodplain along the upstream 1200 ft of Reach A, there was not room for the construction of a diversion channel. This problem (the confined floodplain) was the reason for the trial of a flexible tube dewatering during the pilot test. There were many problems with this system, and on review of the systems performance and cost, it was decided to pursue other alternatives. Hence, a cofferdam system was investigated for use along the confined section of reach A. The dewatering system should be able to pass flows of 30 cfs normally, and remain stable at slightly higher flows (~50-70 cfs). Two alternatives for dewatering in this manner were investigated: using jersey barriers to reroute the water, and using a cofferdam system specifically designed for this sort of application (e.g. Portadam). Both systems will need to be analyzed for hydraulic conveyance as well as stability within the channel.

It is important to note that a dewatering system of this type (not using a diversion channel) will have to be used for over 5000 ft of channel in the area of Reach D. Hence, the use of a cofferdam system within the upstream portion of Reach A will allow for a check of its applicability to reaches of longer length.

INTER-FLUVE, INC.

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MEMORANDUM

To: *Silver Bow Creek, SSTOU, SubArea 1, Reach A*
From: *Martin Doyle*
Date: *4/8/98*
In Regards To: *Upstream Reach A Dewatering: Effectiveness of Cofferdams*

Due to the confined nature of the floodplain along the upstream 1200 ft of Reach A, a cofferdam system will need to be used for dewatering. We analyzed two options for dewatering this reach: jersey barriers and cofferdams. Analysis of a jersey barrier system showed that, due to stability problems with the barriers, they could not be used (see memo regarding this). The use of cofferdams for dewatering is recommended based on their structural stability, and their height (designed using 5 ft dams). We assumed that Portadams (or a structure similar to it) would be used.

We used HEC-RAS to model the effect of constricting the flow using cofferdams. We modeled constricting the flow based on a horizontal distance of 10 ft from the top of the cofferdam to the top bank of the channel (estimated from Clear Creek Hydrology Cross-sections), or assuming a 5-ft high cofferdam (which corresponds to a 5-ft wide cofferdam), then the base of the cofferdam should be placed 5 ft from the toe of channel bank. This placement was intended to allow for normal flows (30 cfs) to be passed without overtopping the cofferdams and to allow for maximum construction space on the dry side of the cofferdam. This spacing, however, does cause normal flows (~30 cfs) to spill out onto the immediate floodplain. However, even at 70 cfs, less than 12 ft of the floodplain is inundated (measured outward from the channel bank).

The attached tables show the results of the HEC-RAS modeling for 30, 50 and 70 cfs. The results indicate that 30 cfs will be easily contained within the diversion system. Similarly, 50 cfs will be contained within the system. However, at flows above 50 cfs, the backwater effects where the flows enter the confined area start to become significant. Due to this, there may need to be some field modification of the entrance to the diversion (e.g. starting the dams farther upstream for a more gradual transition to the channel).

U/S Reach A, Portadam effect, M. Doyle 4/8/98
Q= 30 cfs

Reach	River Sta	Vel Chnl (ft/s)	W.S. Elev (ft)	Min Ch El (ft)	Flow Depth	Top Width (ft)	Top W Chnl (ft)	Top W Right (ft)
a	976	0.25	5416.71	5412.51	4.2	69.99	26.1	38.03
a	975.857*	0.26	5416.71	5412.51	4.2	66.22	29.03	31.22
a	975.714*	0.25	5416.71	5412.52	4.19	57.89	31.97	19.79
a	975.571*	0.24	5416.71	5412.52	4.19	51.63	34.9	10.37
a	975.428*	0.23	5416.71	5412.52	4.19	52.97	37.85	8.41
a	975.285*	0.26	5416.71	5412.52	4.19	42.41	35.52	6.89
a	975.142*	0.38	5416.71	5412.53	4.18	30.56	24.92	5.64
a	975	1.41	5416.68	5412.9	3.78	13.31	8.78	4.53
a	974.5	Bridge			0			
a	974	1.38	5416.17	5412.75	3.42	16.85	8.58	8.27
a	973.5	Bridge			0			
a	973	1.75	5414.55	5411.36	3.19	11.56	7.22	4.33
a	972	1.67	5414.46	5411.22	3.24	14.36	9.09	5.27
a	971	4.18	5414	5412.15	1.85	9.26	7.14	2.12
a	970.2	2.57	5413.47	5411	2.47	16.89	7.47	9.43
a	970.19	2.68	5412.94	5410.1	2.84	12.48	7.9	4.59
a	970.184	3.02	5412.39	5409.69	2.7	11.35	7.76	3.59
a	970.183	5.36	5411.75	5409.61	2.14	6.46	6.46	
a	970.1821	2.91	5411.68	5409.34	2.34	9.39	6.24	3.15
a	970.182	2.68	5411.69	5409.34	2.35	10.34	7.17	3.17
a	970.181	3.16	5411.37	5409.23	2.14	9.45	6.98	2.47
a	970.1809	2.7	5411.4	5409.23	2.17	10.66	8.12	2.54
a	970.18	5.03	5410.74	5409.2	1.54	7.63	7.44	0.19
a	961	1.8	5410.17	5409.23	0.94	26.49	26.49	
a	960	1.79	5409.84	5408.89		26.5	26.5	

coffer dams

U/S Reach A, Portadam effect, M. Doyle 4/8/98
Q= 50 cfs

Reach	River Sta	Vel Chnl (ft/s)	W.S. Elev (ft)	Min Ch El (ft)	Flow Depth	Top Width (ft)	Top W Chnl (ft)	Top W Right (ft)
a	976	0.34	5417.29	5412.51	4.78	75.28	26.1	41.86
a	975.857*	0.36	5417.29	5412.51	4.78	71.04	29.03	34.5
a	975.714*	0.35	5417.29	5412.52	4.77	67.04	31.97	27.31
a	975.571*	0.34	5417.29	5412.52	4.77	55.54	34.9	12.51
a	975.428*	0.32	5417.29	5412.52	4.77	57.12	37.85	10.71
a	975.285*	0.36	5417.29	5412.52	4.77	44.17	35.52	8.65
a	975.142*	0.53	5417.28	5412.53	4.75	32.55	25.56	6.99
a	975	1.81	5417.24	5412.9	4.34	14.86	9.34	5.53
a	974.5	Bridge			0			
a	974	1.77	5416.66	5412.75	3.91	18.29	9.01	9.28
a	973.5	Bridge			0			
a	973	2.28	5415.08	5411.36	3.72	13.91	7.74	6.17
a	972	2.14	5414.95	5411.22	3.73	16.18	9.71	6.47
a	971	4.69	5414.41	5412.15	2.26	13.05	7.62	5.44
a	970.2	2.94	5413.94	5411	2.94	18.58	7.94	10.64
a	970.19	3.17	5413.39	5410.1	3.29	15.96	8.36	7.6
a	970.184	3.6	5412.8	5409.69	3.11	14.59	8.18	6.42
a	970.183	5.42	5412.24	5409.61	2.63	9.99	7.63	2.36
a	970.1821	3.56	5412.14	5409.34	2.8	11.39	6.88	4.51
a	970.182	3.24	5412.16	5409.34	2.82	12.2	7.64	4.55
a	970.181	3.84	5411.79	5409.23	2.56	11.27	7.41	3.86
a	970.1809	3.28	5411.83	5409.23	2.6	12.54	8.56	3.98
a	970.18	5.81	5411.08	5409.2	1.88	9.36	7.78	1.59
a	961	2.19	5410.4	5409.23	1.17	26.89	26.89	
a	960	2.16	5410.07	5408.89	1.18	26.91	26.91	

U/S Reach A, Portadam effect, M. Doyle 4/8/98
Q= 70 cfs

Reach	River Sta	Vel Chnl (ft/s)	W.S. Elev (ft)	Min Ch El (ft)	Flow Depth	Top Width (ft)	Top W Chnl (ft)	Top W Right (ft)
a	976	0.42	5417.73	5412.51	5.22	79.63	26.1	45.09
a	975.857*	0.44	5417.73	5412.51	5.22	74.75	29.03	37.04
a	975.714*	0.43	5417.73	5412.52	5.21	70.98	31.97	29.98
a	975.571*	0.42	5417.73	5412.52	5.21	58.68	34.9	14.42
a	975.428*	0.4	5417.73	5412.52	5.21	59.09	37.85	11.59
a	975.285*	0.45	5417.73	5412.52	5.21	45.37	35.52	9.85
a	975.142*	0.65	5417.73	5412.53	5.2	33.59	25.56	8.03
a	975	2.13	5417.66	5412.9	4.76	16.06	9.76	6.3
a	974.5	Bridge			0			
a	974	2.08	5417.04	5412.75	4.29	19.39	9.34	10.05
a	973.5	Bridge			0			
a	973	2.68	5415.46	5411.36	4.1	15.14	8.13	7.01
a	972	2.51	5415.32	5411.22	4.1	17.39	10.02	7.37
a	971	4.97	5414.75	5412.15	2.6	14.3	8	6.3
a	970.2	3.2	5414.3	5411	3.3	19.89	8.3	11.58
a	970.19	3.51	5413.74	5410.1	3.64	18.63	8.71	9.92
a	970.184	3.99	5413.13	5409.69	3.44	17.14	8.51	8.63
a	970.183	5.58	5412.62	5409.61	3.01	13.04	8.01	5.04
a	970.1821	4.03	5412.51	5409.34	3.17	12.79	7.38	5.41
a	970.182	3.66	5412.53	5409.34	3.19	13.48	8.01	5.47
a	970.181	4.32	5412.13	5409.23	2.9	11.75	7.75	4
a	970.1809	3.71	5412.17	5409.23	2.94	13.78	8.91	4.87
a	970.18	6.31	5411.37	5409.2	2.17	10.62	8.07	2.55
a	961	2.49	5410.6	5409.23	1.37	27.22	27.22	
a	960	2.48	5410.26	5408.89	1.37	27.23	27.23	

roller dams

INTER-FLUVE, INC.

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MEMORANDUM

To: *Silver Bow Creek, SSTOU SubArea 1, Reach A*
From: *Shelly Donner / Martin Doyle*
Date: *4/8/98*
In Regards To: *Upstream Reach A Jersey Barrier Dewatering*

One approach to dewatering the upper section in Reach A was the use of highway jersey barriers to create a small dammed off dry area. A full analysis was done for this method, including; a HEC-RAS model to determine the height and top width of water with the barriers in place, a stability analysis using forces acting on the barriers and also cost and feasibility. It was found that the barriers were not an acceptable alternative for dewatering, due to two major factors. The first being, that a 4-feet high barrier would not with stand the hydrostatic forces and would overturn. However, if the barrier was designed to withstand the hydrostatic forces the weight, approximately 10,000 lbs., will not allow ease in moving. The following paragraphs discuss the analysis of the jersey barriers and the findings.

Stability of the jersey barriers was analyzed under the conditions of dewatering in upper reach A. Due to the fact that jersey barriers are not normally used for the purpose of creating dams, the analysis looked at the jersey barrier as a small dam. The main concern was that the barrier would overturn under the hydrostatic force of the water. Analysis used a force diagram to show relevant forces and the point at which they were acting (see attached), and gave the information required to determine the point at which the barrier would overturn in the form of moments.

Under the most extreme conditions that the barrier would have to withstand, a normal barrier is not adequate, the barrier must be a minimum of 3.4-feet high to contain 30-cfs of flow. Thus a barrier 4 feet high would adequate to contain the 30-cfs flow and 50-cfs flow from HEC station 975 to 970.18. A special barrier would have to be ordered to get the 4-feet height. Based on a conversation with KH Concrete in Ennis, MT on 4/6/98, concrete barriers up to 4 ft tall can be constructed for a reasonable cost ($250 for 4 ft compared to $180 for standard). It is important to note that the determination of 10-ft spacing between the barrier and bank was based on the results of HEC-RAS modeling, and that the spacing may need to be adjusted in the field if it is not providing adequate conveyance.

This is particularly true at the upstream entrance to the diversion system where there may be significant backwatering. However, any adjustment to the spacing should be made in light of the need for space on the construction (dry) side of the barrier.

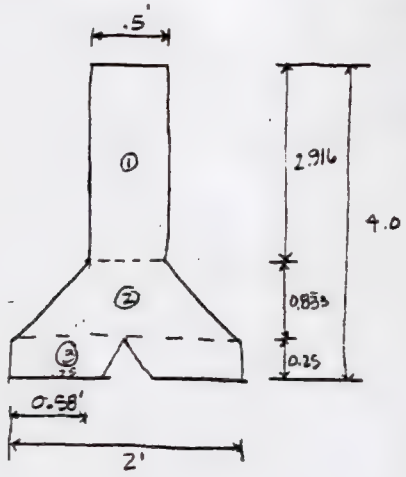
Using the 4-feet high barrier and the weight of concrete to be 150 lbs/ft^3 , the force of weight was found. There is an uplift pressure that is acting on the barrier, which is believed to be a very conservative estimate as to the actual force that is acting upward on the barrier. The other forces acting on the barrier were hydrostatic vertical and horizontal forces, found from the weight of water and the area over which the water is acting. The forces that act to overturn the barrier are the hydrostatic horizontal force and the uplift force; the forces acting to stabilize the barrier are the weight and the vertical hydrostatic force. When the overturning moments are greater than the righting moment, the barrier will overturn.

The attached sheets show the original calculation sheet using a 4-feet barrier, which under the conditions of a 4-feet depth of water on the left side the barrier will overturn. In addition spreadsheets were used to find at what point the barrier was stabile and to what degree the uplifting force determined the stability. A secondary option was considered in which the barrier bottom width was widened with 6-inch flanges on either side, to create a more stable barrier. Again an analysis was performed as to the effect of the uplift force. The following table summarizes the findings for a stabile barrier, with a safety factor> 1.0;

Barrier Description	Uplift Force	Max. Depth of Water for Stable Barrier
4 ft tall, 2ft wide base	Yes	3.2 feet
4 ft tall, 2ft wide base	No	3.9 feet
4 ft tall, 3ft wide base	Yes	3.9 feet
4 ft tall, 3ft wide base	No	4.0 feet

The decision as to the size and style of barrier required must be based on the fact that a minimum water depth that needs to be contained is 3.4 feet with and a maximum of 4 feet of depth needs to be contained. The question of safety factor needs to be addressed and to what degree the uplift force is relevant, before a barrier size could be selected.

Jersey Barrier Overturning Analysis



$\bar{x} = 1.0'$

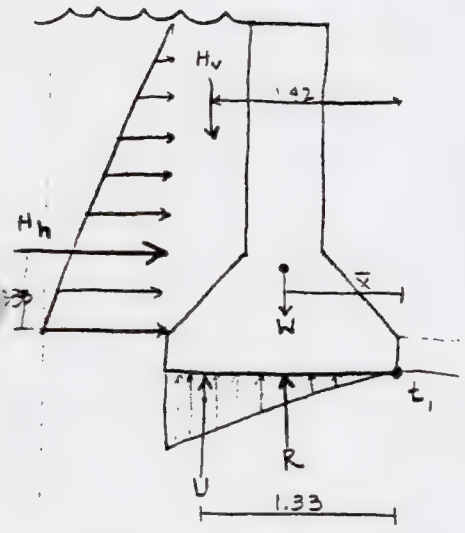
$\bar{y}$:

Segment	A	$\tilde{y}$	$A\tilde{y}$
①	1.458	2.541	3.705
②	1.183	0.583	0.690
③	0.219	0.119	0.026
③	0.219	0.119	0.026
	3.079		Σ 4.447

$$\bar{y} = \frac{\Sigma A\tilde{y}}{\Sigma A} = \frac{4.447}{3.079} = 1.444'$$

$\gamma_c = 150\ lb/ft^3$

$\gamma_w = 62.5\ lb/ft^3$



W = weight of barrier per unit width

$= A\,\gamma_c = 3.079(150) = 461.85\ lb/ft$

R = resultant force = $-W$

U = uplift pressure

$$= \frac{(62.5)\,4}{2}(2) = 250\ lb/ft$$

Hydrostatic Forces:

$$H_v = (62.5)(1)\left[(0.58)(0.833)\tfrac{1}{2} + (2.916)(0.58)\right]$$

$= 120.80\ lb/ft$

$H_h = \frac{1}{2}(62.5)(4)^2 = 500\ lb/ft$

Overturning Force: H_h and U

$(500)(1.333) + (250)(1.33) = 999\ lb\cdot ft/ft$

Righting Force: H_v and W

$(120.80)(1.42) + (461.85)(1) = 633.39\ lbft/ft$

Reference: Water Resources Engineering; Linsley, Franzini, Tchobanoglous McGrawHill 1992 p. 226

Jersey Barrier Force Calculations

Barrier Information

Height (ft)	Width (ft)	x-centroid (ft)	y-centroid (ft)	Weight (lb/ft)
4	2	1	1.444	461.85

Water Forces

Depth (ft)	Uplift (lb/ft)	U-centroid (ft)	Horizontal (lb/ft)	H-centroid (ft)	Vertical (lb/ft)	V-centroid (ft)
4	250	1.33	500.00	1.33	120.84	1.42
3.9	243.8	1.33	475.31	1.30	117.21	1.42
3.8	237.5	1.33	451.25	1.27	113.59	1.42
3.7	231.3	1.33	427.81	1.23	109.96	1.42
3.6	225	1.33	405.00	1.20	106.34	1.42
3.5	218.8	1.33	382.81	1.17	102.71	1.42
3.4	212.5	1.33	361.25	1.13	99.09	1.42
3.3	206.3	1.33	340.31	1.10	95.46	1.42
3.2	200	1.33	320.00	1.07	91.84	1.42
3.1	193.8	1.33	300.31	1.03	88.21	1.42
3	187.5	1.33	281.25	1.00	84.59	1.42
2.9	181.3	1.33	262.81	0.97	80.96	1.42
2.8	175	1.33	245.00	0.93	77.34	1.42

Tendency for Overturning

Overturing (lb-ft/ft)	Righting (lb-ft/ft)	Difference	Factor Safety
1000.00	633.44	-366.56	0.633442
942.91	628.29	-314.61	0.666338
888.25	623.15	-265.10	0.701545
835.97	618.00	-217.97	0.739261
786.00	612.85	-173.15	0.77971
738.28	607.70	-130.58	0.823134
692.75	602.56	-90.19	0.869804
649.34	597.41	-51.93	0.92002
608.00	592.26	-15.74	0.974115
568.66	587.11	18.46	1.032459
531.25	581.97	50.72	1.095467
495.72	576.82	81.10	1.163602
462.00	571.67	109.67	1.237385

Description:

Barrier 4ft tall analysis, considering the uplift forces caused by water seepage under the barrier.

Jersey Barrier Force Calculations

Barrier Information

Height (ft)	Width (ft)	x-centroid (ft)	y-centroid (ft)	Weight (lb/ft)
4	2	1	1.444	461.85

Water Forces

Depth (ft)	Uplift (lb/ft)	U-centroid (ft)	Horizontal (lb/ft)	H-centroid (ft)	Vertical (lb/ft)	V-centroid (ft)
4	250	1.33	500.00	1.33	120.84	1.42
3.9	243.8	1.33	475.31	1.30	117.21	1.42
3.8	237.8	1.33	451.25	1.27	113.59	1.42
3.7	231.3	1.33	427.81	1.23	109.96	1.42
3.6	225	1.33	405.00	1.20	106.34	1.42
3.5	218.8	1.33	382.81	1.17	102.71	1.42
3.4	212.5	1.33	361.25	1.13	99.09	1.42
3.3	206.3	1.33	340.31	1.10	95.46	1.42
3.2	200	1.33	320.00	1.07	91.84	1.42
3.1	193.8	1.33	300.31	1.03	88.21	1.42
3	187.5	1.33	281.25	1.00	84.59	1.42
2.9	181.3	1.33	262.81	0.97	80.96	1.42
2.8	175	1.33	245.00	0.93	77.34	1.42

Tendency for Overturning

Overturing (lb-ft/ft)	Righting (lb-ft/ft)	Difference	Factor Safety
666.67	633.44	-33.22	0.950163
617.91	628.29	10.39	1.016812
571.58	623.15	51.56	1.090212
527.64	618.00	90.36	1.171262
486.00	612.85	126.85	1.261012
446.61	607.70	161.09	1.360691
409.42	602.56	193.14	1.471745
374.34	597.41	223.07	1.595885
341.33	592.26	250.93	1.735142
310.32	587.11	276.79	1.891947
281.25	581.97	300.72	2.069216
254.05	576.82	322.77	2.270477
228.67	571.67	343.01	2.500023

Description:

Barrier 4ft tall analysis, with out considering the uplift forces caused by water seepage under the barrier.

Jersey Barrier Force Calculations

Barrier Information

Height (ft)	Width (ft)	x-centroid (ft)	y-centroid (ft)	Weight (lb/ft)
4	3	1.5	1.382	536.85

Water Forces

Depth (ft)	Uplift (lb/ft)	U-centroid (ft)	Horizontal (lb/ft)	H-centroid (ft)	Vertical (lb/ft)	V-centroid (ft)
4	375	2.00	500.00	1.33	230.21	1.62
3.9	365.6	2.00	475.31	1.30	223.46	1.62
3.8	356.3	2.00	451.25	1.27	216.71	1.62
3.7	346.9	2.00	427.81	1.23	209.96	1.62
3.6	337.5	2.00	405.00	1.20	203.21	1.62
3.5	328.1	2.00	382.81	1.17	196.46	1.62
3.4	318.8	2.00	361.25	1.13	189.71	1.62
3.3	309.4	2.00	340.31	1.10	182.96	1.62
3.2	300	2.00	320.00	1.07	176.21	1.62
3.1	290.6	2.00	300.31	1.03	169.46	1.62
3	281.3	2.00	281.25	1.00	162.71	1.62
2.9	271.9	2.00	262.81	0.97	155.96	1.62
2.8	262.5	2.00	245.00	0.93	149.21	1.62

Tendency for Overturning

Overturing (lb-ft/ft)	Righting (lb-ft/ft)	Difference	Factor Safety
1416.67	1178.22	-238.44	0.831686
617.91	1167.29	549.38	1.889101
571.58	1156.35	584.77	2.023069
527.64	1145.42	617.78	2.17085
486.00	1134.48	648.48	2.334326
446.61	1123.55	676.93	2.515698
409.42	1112.61	703.20	2.717555
374.34	1101.68	727.33	2.942956
341.33	1090.74	749.41	3.195534
310.32	1079.81	769.48	3.479625
281.25	1068.87	787.62	3.800435
254.05	1057.94	803.89	4.164254
228.67	1047.00	818.34	4.578727

Description:

Barrier 4ft tall and 3ft wide analysis, considering the uplift forces caused by water seepage under the barrier.

Jersey Barrier Force Calculations

Barrier Information

Height (ft)	Width (ft)	x-centroid (ft)	y-centroid (ft)	Weight (lb/ft)
4	3	1.5	1.382	536.85

Water Forces

Depth (ft)	Uplift (lb/ft)	U-centroid (ft)	Horizontal (lb/ft)	H-centroid (ft)	Vertical (lb/ft)	V-centroid (ft)
4	375	2.00	500.00	1.33	230.21	1.62
3.9	366.6	2.00	475.31	1.30	223.46	1.62
3.8	356.3	2.00	451.25	1.27	216.71	1.62
3.7	346.9	2.00	427.81	1.23	209.96	1.62
3.6	337.5	2.00	405.00	1.20	203.21	1.62
3.5	328.1	2.00	382.81	1.17	196.46	1.62
3.4	318.8	2.00	361.25	1.13	189.71	1.62
3.3	309.4	2.00	340.31	1.10	182.96	1.62
3.2	300	2.00	320.00	1.07	176.21	1.62
3.1	290.6	2.00	300.31	1.03	169.46	1.62
3	281.3	2.00	281.25	1.00	162.71	1.62
2.9	271.9	2.00	262.81	0.97	155.96	1.62
2.8	262.5	2.00	245.00	0.93	149.21	1.62

Tendency for Overturning

Overturing (lb-ft/ft)	Righting (lb-ft/ft)	Difference	Factor Safety
666.67	1178.22	511.56	1.767333
617.91	1167.29	549.38	1.889101
571.58	1156.35	584.77	2.023069
527.64	1145.42	617.78	2.17085
486.00	1134.48	648.48	2.334326
446.61	1123.55	676.93	2.515698
409.42	1112.61	703.20	2.717555
374.34	1101.68	727.33	2.942956
341.33	1090.74	749.41	3.195534
310.32	1079.81	769.48	3.479625
281.25	1068.87	787.62	3.800435
254.05	1057.94	803.89	4.164254
228.67	1047.00	818.34	4.578727

Description:

Barrier 4ft tall with a 3ft wide base analysis, with out considering the uplift forces caused by water seepage under the barrier.

APPENDIX D

TAILINGS/IMPACTED SOILS REMOVAL

Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

APPENDIX D-1

Test Pit Results Within the Horizontal Extent of Tailings/Impacted Soil

Appendix D

Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1DN-7002	746036	1209209	5365.56	0.00	5365.56
1DN-7003	746152	1209128	5366.56	4.33	5362.23
1DN-7006	746189	1208975	5366.62	1.33	5365.29
1DN-7015	746171	1208542	5362.49	0.00	5362.49
1DN-7018	746205	1208395	5362.65	0.00	5362.65
1DN-7021	746229	1208251	5363.13	0.00	5363.13
1DN-7022	746397	1208298	5365.82	0.33	5365.49
1DN-7024	746139	1208167	5361.46	2.67	5358.79
1DN-7025	746256	1208102	5362.13	0.00	5362.13
1DN-7028	746360	1207975	5361.90	2.33	5359.57
1DN-7036	746330	1207310	5361.76	2.00	5359.76
1DN-7038	746169	1207212	5360.05	0.00	5360.05
1DN-7039	746312	1207159	5361.17	2.67	5358.50
1DS-7001	745866	1209137	5372.24	2.67	5369.57
1DS-7004	745887	1208992	5374.21	8.67	5365.54
1DS-7005	746014	1208981	5368.73	4.00	5364.73
1DS-7007	745910	1208845	5372.33	4.67	5367.66
1DS-7008	746037	1208834	5367.63	2.67	5364.96
1DS-7009	746159	1208824	5363.85	3.33	5360.52
1DS-7010	745933	1208699	5371.84	5.67	5366.17
1DS-7011	746060	1208687	5367.33	5.33	5362.00
1DS-7012	746172	1208675	5362.96	0.00	5362.96
1DS-7013	745955	1208551	5371.15	5.00	5366.15
1DS-7014	746083	1208539	5367.10	6.33	5360.77
1DS-7016	745976	1208403	5370.23	5.00	5365.23
1DS-7017	746107	1208384	5366.00	1.00	5365.00
1DS-7019	745999	1208255	5369.83	8.00	5361.83
1DS-7020	746081	1208239	5364.06	2.00	5362.06
1DS-7023	746047	1208112	5365.88	7.67	5358.21
1DS-7026	746132	1208016	5363.83	7.00	5356.83

Appendix D

Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1DS-7027	746252	1208019	5362.20	3.33	5358.87
1DS-7029	746150	1207852	5364.23	1.33	5362.90
1DS-7030	746307	1207881	5361.87	3.33	5358.54
1DS-7031	746167	1207704	5363.57	2.67	5360.90
1DS-7032	746324	1207731	5362.42	2.67	5359.75
1DS-7033	746185	1207557	5362.77	0.33	5362.44
1DS-7034	746323	1207588	5361.14	2.33	5358.81
1DS-7035	746139	1207413	5361.75	6.67	5355.08
1DS-7037	746070	1207244	5362.24	0.00	5362.24
1DS-7040	746023	1207090	5362.68	2.00	5360.68
1N-1004	743263	1220715	5411.94	4.00	5407.94
1N-1006	743368	1220593	5412.77	2.00	5410.77
1N-1007	743530	1220567	5414.88	6.33	5408.55
1N-1009	743408	1220468	5412.40	2.00	5410.40
1N-1010	743309	1220213	5410.48	2.33	5408.15
1N-1011	743383	1220071	5411.98	0.33	5411.65
1N-1012	743447	1219947	5411.21	0.00	5411.21
1N-1013	743508	1219816	5410.75	0.33	5410.42
1N-1014	743573	1219674	5411.25	0.00	5411.25
1N-1016	743628	1219536	5410.25	1.67	5408.58
1N-1018	743685	1219405	5409.41	1.67	5407.74
1N-1019	743746	1219261	5408.28	1.67	5406.61
1N-1025	743994	1218872	5408.09	0.67	5407.42
1N-1029	744052	1218728	5408.48	4.00	5404.48
1N-1033	744086	1218593	5407.09	3.67	5403.42
1N-1036	744025	1218432	5405.53	4.33	5401.20
1N-1037	744244	1218482	5409.32	0.67	5408.65
1N-1039	744071	1218286	5408.06	7.33	5400.73
1N-1040	744237	1218305	5412.55	2.67	5409.88
1N-1041	743995	1218137	5404.43	3.33	5401.10

Appendix D

Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1N-1042	744012	1217994	5403.47	2.00	5401.47
1N-1044	744055	1217835	5402.38	0.00	5402.38
1N-1046	744100	1217692	5401.23	2.33	5398.90
1N-1048	744141	1217555	5399.06	1.33	5397.73
1N-1049	744283	1217593	5399.41	0.67	5398.74
1N-1052	744312	1217461	5401.42	3.33	5398.09
1N-1059	744460	1217013	5397.52	1.33	5396.19
1N-1062	744496	1216864	5396.38	1.67	5394.71
1N-1064	744458	1216692	5395.54	2.67	5392.87
1N-1065	744553	1216737	5397.94	1.67	5396.27
1N-1068	744601	1216594	5397.58	1.33	5396.25
1N-1071	744654	1216449	5396.22	1.00	5395.22
1N-1074	744707	1216317	5395.01	1.67	5393.34
1N-1076	744736	1216172	5394.57	2.00	5392.57
1N-1077	744889	1216230	5395.89	1.33	5394.56
1N-1079	744815	1216023	5395.22	2.00	5393.22
1N-1081	744737	1215757	5391.57	2.33	5389.24
1N-1082	744854	1215875	5394.76	5.00	5389.76
1N-1084	744904	1215744	5393.07	5.00	5388.07
1N-1086	744936	1215608	5393.51	1.33	5392.18
1N-1088	744971	1215450	5393.02	1.33	5391.69
1N-1090	744983	1215256	5391.59	1.67	5389.92
1N-1092	744841	1215091	5390.76	2.67	5388.09
1N-1094	744840	1214938	5390.47	2.33	5388.14
1N-1096	744845	1214485	5389.61	3.33	5386.28
1N-1097	744994	1214490	5390.10	1.33	5388.77
1N-1099	744877	1214190	5389.37	2.00	5387.37
1N-1100	744794	1214017	5386.33	1.67	5384.66
1N-1102	744969	1213884	5388.88	1.00	5387.88
1N-1104	744837	1213727	5385.76	3.67	5382.09

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Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1N-1105	744959	1213724	5386.27	5.00	5381.27
1N-1108	744854	1213586	5384.71	1.67	5383.04
1N-1109	744964	1213576	5385.83	0.67	5385.16
1N-1110	744858	1213430	5387.50	1.00	5386.50
1N-1111	744965	1213433	5384.71	0.67	5384.04
1N-1112	744829	1213281	5387.25	3.67	5383.58
1N-1113	744963	1213269	5384.99	0.33	5384.66
1N-1114	744855	1213145	5385.32	2.67	5382.65
1N-1115	744966	1213120	5384.03	1.67	5382.36
1N-1117	744897	1212981	5384.35	1.67	5382.68
1N-1118	745028	1212976	5384.71	0.67	5384.04
1N-1119	744785	1212901	5383.89	3.33	5380.56
1N-1120	744954	1212835	5384.50	1.33	5383.17
1N-1121	745070	1212834	5385.56	5.33	5380.23
1N-1125	744961	1212687	5385.17	1.67	5383.50
1N-1137	745223	1211899	5383.08	2.00	5381.08
1N-1143	745245	1211372	5379.11	2.67	5376.44
1N-1145	745487	1211238	5385.52	1.33	5384.19
1N-1147	745528	1211130	5385.36	1.33	5384.03
1N-1151	745697	1210824	5376.48	0.00	5376.48
1N-1154	745713	1210704	5376.40	1.67	5374.73
1N-1157	745731	1210550	5373.65	0.00	5373.65
1N-1160	745745	1210391	5373.97	0.00	5373.97
1N-1165	745986	1209989	5368.90	1.67	5367.23
1N-1167	746037	1209850	5368.65	1.67	5366.98
1N-1169	746097	1209719	5367.34	3.33	5364.01
1N-1172	746159	1209576	5370.27	0.33	5369.94
1N-1173	746041	1209436	5365.99	1.67	5364.32
1N-1176	746287	1206937	5360.15	2.33	5357.82
1N-1178	746252	1206791	5359.11	1.00	5358.11

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Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1N-1181	746213	1206651	5359.90	1.33	5358.57
1N-1187	746006	1206434	5357.92	2.00	5355.92
1N-1188	745932	1206509	5356.56	3.67	5352.89
1N-1192	745854	1206291	5357.12	2.67	5354.45
1N-1194	745886	1206142	5358.56	5.33	5353.23
1N-1195	745785	1206031	5357.01	4.33	5352.68
1N-1196	745682.	1205918	5358.12	2.00	5356.12
1N-1198	745485	1205893	5355.60	3.00	5352.60
1N-1200	745372	1205784	5354.85	2.33	5352.52
1N-1201	745452	1205626	5356.10	5.33	5350.77
1N-1203	745287	1205664	5357.27	0.67	5356.60
1N-1204	745361	1205519	5354.31	1.33	5352.98
1N-1206	745204	1205546	5354.24	2.00	5352.24
1N-1207	745258	1205390	5354.24	3.33	5350.91
1N-1211	745397	1205206	5353.88	1.33	5352.55
1N-1214	745432	1204954	5352.84	3.33	5349.51
1N-1215	745457	1205072	5353.42	2.67	5350.75
1N-1219	745526	1204867	5352.05	2.67	5349.38
1N-1228	745644	1204139	5350.14	2.00	5348.14
1N-1269	746444	1201156	5338.31	3.00	5335.31
1N-1272	746461	1201247	5338.59	3.00	5335.59
1N-1274	746519	1201059	5338.93	2.00	5336.93
1N-1275	746568	1200887	5340.51	2.00	5338.51
1N-1276	746573	1200793	5339.92	1.00	5338.92
1N-1277	746640	1200675	5339.09	0.00	5339.09
1N-1285	747062	1199244	5329.02	2.67	5326.35
1N-1286	747008	1199108	5328.62	6.00	5322.62
1N-1287	746935	1198959	5327.87	0.00	5327.87
1N-1289	746887	1198823	5327.51	1.33	5326.18
1N-1291	746862	1198591	5326.17	2.00	5324.17

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Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1N-1297	746770	1198190	5328.52	1.00	5327.52
1N-1300	746732	1198036	5327.12	5.67	5321.45
1N-1303	746698	1197879	5324.24	2.00	5322.24
1N-1304	746529	1197698	5324.08	1.67	5322.41
1N-1305	746699	1197731	5329.19	3.00	5326.19
1N-1310	746620	1197354	5325.15	2.33	5322.82
1N-1312	746670	1197220	5324.72	3.00	5321.72
1N-5007	745460	1205398	5355.37	2.00	5353.37
1N-5014	746847	1198699	5325.88	1.33	5324.55
1N-5015	746638	1198122	5325.05	2.67	5322.38
1N-5016	743145	1221025	5417.24	3.00	5414.24
1N-5017	743094	1221137	5418.83	0.00	5418.83
1N-5018	743075	1221284	5419.11	4.67	5414.44
1N-5022	743202	1221384	5415.66	5.00	5410.66
1N-5023	743183	1221243	5415.62	4.00	5411.62
1S-1001	743063	1220927	5416.99	4.33	5412.66
1S-1002	743100	1220799	5417.12	0.00	5417.12
1S-1003	743147	1220645	5415.05	2.33	5412.72
1S-1008	743251	1220374	5413.56	1.33	5412.23
1S-1015	743492	1219481	5408.40	1.00	5407.40
1S-1017	743547	1219343	5407.99	2.67	5405.32
1S-1021	743833	1218936	5407.59	1.33	5406.26
1S-1024	743866	1218797	5407.67	0.00	5407.67
1S-1027	743748	1218691	5408.15	2.67	5405.48
1S-1028	743903	1218650	5407.02	1.67	5405.35
1S-1031	743798	1218548	5408.29	2.33	5405.96
1S-1032	743956	1218519	5405.15	3.33	5401.82
1S-1035	743842	1218431	5408.07	0.33	5407.74
1S-1038	743904	1218269	5409.35	4.33	5405.02
1S-1043	743943	1217817	5402.44	0.33	5402.11

Appendix D

Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1S-1045	743983	1217678	5401.50	2.00	5399.50
1S-1047	744028	1217524	5401.73	0.67	5401.06
1S-1051	744188	1217406	5398.95	2.33	5396.62
1S-1054	744233	1217268	5398.10	1.67	5396.43
1S-1056	744150	1217088	5403.03	0.67	5402.36
1S-1057	744269	1217106	5399.50	1.67	5397.83
1S-1058	744319	1216980	5397.79	2.33	5395.46
1S-1061	744360	1216828	5398.15	2.00	5396.15
1S-1063	744291	1216609	5402.11	0.67	5401.44
1S-1066	744338	1216469	5398.64	2.00	5396.64
1S-1067	744452	1216522	5400.01	0.00	5400.01
1S-1069	744387	1216321	5398.12	1.00	5397.12
1S-1070	744521	1216388	5395.25	3.00	5392.25
1S-1072	744427	1216186	5397.69	0.00	5397.69
1S-1073	744577	1216246	5394.26	5.00	5389.26
1S-1075	744617	1216094	5393.42	4.67	5388.75
1S-1078	744652	1215963	5394.13	2.00	5392.13
1S-1080	744610	1215780	5395.42	0.33	5395.09
1S-1083	744752	1215673	5394.79	0.00	5394.79
1S-1085	744815	1215541	5393.33	2.00	5391.33
1S-1087	744833	1215372	5391.47	3.00	5388.47
1S-1089	744849	1215226	5389.58	2.67	5386.91
1S-1091	744687	1215115	5392.07	1.00	5391.07
1S-1093	744697	1214971	5390.07	1.33	5388.74
1S-1095	744701	1214809	5389.94	2.33	5387.61
1S-1098	744604	1214138	5390.26	1.00	5389.26
1S-1101	744795	1213875	5387.19	2.00	5385.19
1S-1103	744672	1213729	5388.37	0.67	5387.70
1S-1106	744809	1213645	5386.33	1.33	5385.00
1S-1107	744706	1213591	5386.34	1.00	5385.34

Appendix D

Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1S-1116	744741	1212995	5386.22	0.33	5385.89
1S-1124	744805	1212679	5383.85	4.33	5379.52
1S-1127	744824	1212527	5383.19	2.00	5381.19
1S-1128	744842	1212383	5384.27	1.00	5383.27
1S-1129	744992	1212390	5383.55	1.67	5381.88
1S-1130	744996	1212229	5383.29	1.33	5381.96
1S-1133	745003	1212115	5384.65	6.33	5378.32
1S-1135	744917	1211890	5383.59	1.33	5382.26
1S-1136	745057	1211964	5381.98	1.00	5380.98
1S-1138	745077	1211803	5382.62	4.67	5377.95
1S-1139	745071	1211607	5382.25	6.33	5375.92
1S-1140	745092	1211466	5381.19	3.33	5377.86
1S-1141	745213	1211495	5379.56	3.00	5376.56
1S-1142	745134	1211322	5379.74	4.67	5375.07
1S-1144	745151	1211191	5378.54	4.33	5374.21
1S-1146	745193	1211041	5378.10	2.33	5375.77
1S-1148	745225	1210893	5376.97	3.00	5373.97
1S-1150	745264	1210755	5377.44	4.00	5373.44
1S-1152	745333	1210632	5375.64	1.67	5373.97
1S-1153	745537	1210653	5375.05	4.33	5370.72
1S-1155	745360	1210450	5380.79	7.33	5373.46
1S-1158	745409	1210318	5376.06	0.00	5376.06
1S-1159	745653	1210324	5370.94	3.33	5367.61
1S-1161	745456	1210167	5376.08	0.00	5376.08
1S-1163	745765	1210102	5370.64	3.67	5366.97
1S-1170	745841	1209431	5371.42	3.67	5367.75
1S-1171	745955	1209519	5368.58	0.00	5368.58
1S-1174	745857	1209287	5373.37	0.00	5373.37
1S-1175	746004	1209268	5365.66	2.33	5363.33
1S-1177	746113	1206891	5359.08	2.67	5356.41

Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1S-1179	745933	1206845	5361.57	0.00	5361.57
1S-1180	746041	1206766	5358.87	2.33	5356.54
1S-1182	745835	1206723	5360.74	1.33	5359.41
1S-1183	745956	1206635	5359.06	2.00	5357.06
1S-1185	745788	1206570	5359.66	4.00	5355.66
1S-1186	745879	1206504	5358.62	4.00	5354.62
1S-1189	745760	1206440	5358.59	3.00	5355.59
1S-1190	745845	1206368	5358.71	3.67	5355.04
1S-1191	745725	1206281	5357.73	3.33	5354.40
1S-1193	745687	1206141	5355.41	4.67	5350.74
1S-1197	745541	1205973	5356.01	3.00	5353.01
1S-1199	745277	1205764	5354.36	1.00	5353.36
1S-1202	745188	1205643	5355.26	0.67	5354.59
1S-1205	745105	1205518	5355.82	0.67	5355.15
1S-1208	745103	1205368	5354.51	1.67	5352.84
1S-1209	745236	1205302	5353.45	2.33	5351.12
1S-1210	745193	1205158	5353.55	1.67	5351.88
1S-1213	745250	1205025	5353.28	1.67	5351.61
1S-1217	745311	1204884	5352.93	1.67	5351.26
1S-1218	745459	1204869	5351.33	1.67	5349.66
1S-1221	745512	1204731	5353.41	3.00	5350.41
1S-1222	745428	1204609	5355.12	1.67	5353.45
1S-1223	745565	1204587	5352.92	4.33	5348.59
1S-1224	745493	1204466	5354.02	0.33	5353.69
1S-1225	745617	1204460	5351.51	3.67	5347.84
1S-1226	745678	1204320	5350.87	1.67	5349.20
1S-1227	745563	1204223	5351.27	4.00	5347.27
1S-1229	745752	1203829	5350.16	2.00	5348.16
1S-1231	745793	1203648	5351.06	0.67	5350.39
1S-1233	745873	1203409	5351.41	0.00	5351.41

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Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1S-1236	745904	1203263	5351.21	1.00	5350.21
1S-1243	745936	1203120	5352.01	0.33	5351.68
1S-1256	746084	1202736	5347.43	2.33	5345.10
1S-1259	746063	1202601	5350.18	0.67	5349.51
1S-1261	746111	1202461	5352.10	0.00	5352.10
1S-1263	746186	1202350	5348.02	0.00	5348.02
1S-1264	746212	1202220	5349.09	0.00	5349.09
1S-1270	746388	1201341	5344.49	4.67	5339.82
1S-1271	746347	1201142	5340.76	3.00	5337.76
1S-1273	746415	1201027	5337.85	0.00	5337.85
1S-1278	746659	1200496	5334.35	2.00	5332.35
1S-1279	746720	1200369	5334.84	3.00	5331.84
1S-1280	746774	1200262	5333.74	0.67	5333.07
1S-1281	746872	1200183	5332.89	2.00	5330.89
1S-1282	746893	1200071	5332.70	1.33	5331.37
1S-1283	746965	1199950	5332.78	1.00	5331.78
1S-1284	747024	1199780	5331.49	2.67	5328.82
1S-1288	746774	1198678	5331.79	5.00	5326.79
1S-1290	746745	1198591	5331.69	7.00	5324.69
1S-1292	746698	1198531	5331.49	2.67	5328.82
1S-1293	746827	1198516	5330.44	3.00	5327.44
1S-1294	746693	1198406	5331.73	2.67	5329.06
1S-1295	746554	1198268	5330.27	3.33	5326.94
1S-1296	746677	1198249	5329.49	3.00	5326.49
1S-1298	746464	1198081	5329.35	2.33	5327.02
1S-1299	746567	1198068	5329.64	3.33	5326.31
1S-1301	746459	1197965	5328.54	1.33	5327.21
1S-1302	746604	1197944	5324.87	4.33	5320.54
1S-1306	746377	1197599	5328.51	2.00	5326.51
1S-1307	746501	1197588	5327.23	1.00	5326.23

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Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
1S-1308	746347	1197445	5327.98	1.33	5326.65
1S-1309	746495	1197435	5326.55	1.67	5324.88
1S-1311	746508	1197147	5327.90	1.33	5326.57
1S-1314	746608	1197058	5325.33	0.00	5325.33
1S-1315	746740	1196987	5327.83	3.67	5324.16
1S-1316	746608	1196928	5326.53	1.33	5325.20
1S-1317	746627	1196808	5327.59	0.33	5327.26
1S-1318	746747	1196855	5327.05	2.33	5324.72
1S-5005	744408	1216665	5396.62	2.67	5393.95
1S-5006	744993	1211333	5382.06	0.00	5382.06
1S-5009	745531	1206145	5359.53	2.33	5357.20
1S-5010	745574	1206288	5359.48	1.33	5358.15
1S-5012	745695	1203999	5349.45	0.00	5349.45
1S-5013	747076	1199646	5330.77	1.67	5329.10
BB1001	744745	1214646	5389.60	2.58	5387.02
BB1002	744753	1214547	5390.93	0.00	5390.93
BB1003	744736	1214451	5390.09	1.58	5388.51
BB1004	744734	1214349	5389.90	1.75	5388.15
BB1005	744728	1214250	5389.42	1.33	5388.09
BB1006	744719	1214147	5388.98	1.83	5387.15
BB1007	744706	1214045	5385.90	2.00	5383.90
BB1009	744808	1214148	5388.47	2.00	5386.47
BB1010	744821	1214247	5389.37	1.50	5387.87
BB1011	744824	1214351	5388.98	0.67	5388.31
BB1013	744840	1214555	5390.39	2.08	5388.31
BB1014	744844	1214645	5390.32	1.67	5388.65
BB1015	744850	1214747	5390.85	2.83	5388.02
BB1016	744933	1214744	5391.84	0.00	5391.84
BB1017	744947	1214647	5389.95	3.00	5386.95
BB1018	744940	1214543	5389.96	4.67	5385.29

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Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
BB1019	744935	1214446	5389.66	3.00	5386.66
BB1020	744927	1214344	5392.92	0.00	5392.92
BB1021	744919	1214245	5389.53	1.67	5387.86
BB1023	744887	1214046	5387.71	1.46	5386.25
BB1024	744996	1214043	5389.31	3.92	5385.39
BB1025	745011	1214153	5390.98	3.25	5387.73
BB1026	745018	1214244	5388.44	3.50	5384.94
BB1027	745023	1214348	5388.85	0.83	5388.02
BB1029	745020	1214548	5389.77	3.25	5386.52
BB1030	744925	1213956	5388.03	1.58	5386.45
SC1001	746691	1197134	5323.52	1.92	5321.60
SC1002	746594	1197690	5327.35	1.92	5325.43
SC1003	746600	1197576	5327.33	2.50	5324.83
SC1004	746603	1197487	5326.68	4.25	5322.43
SC1005	746608	1197387	5325.14	1.75	5323.39
SC1006	746602	1197282	5325.37	2.17	5323.20
SC1007	746593	1197189	5323.48	3.00	5320.48
SC1008	746688	1197200	5323.71	0.00	5323.71
SC1009	746691	1197302	5327.17	1.67	5325.50
SC1010	746693	1197398	5327.45	2.00	5325.45
SC1011	746685	1197505	5327.80	1.16	5326.64
SC1012	746685	1197603	5328.24	2.50	5325.74
SC1013	746693	1197705	5328.77	1.58	5327.19
SC1014	746697	1197810	5329.25	2.25	5327.00
SC1017	746507	1197524	5326.27	1.17	5325.10
SC1019	746500	1197296	5326.36	1.67	5324.69
SC1020	746457	1197216	5327.22	1.92	5325.30
SC1021	746413	1197352	5327.55	3.83	5323.72
SC1023	746423	1197577	5327.68	1.17	5326.51
SC1025	746418	1197805	5328.92	1.92	5327.00

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Tailings/Impacted Soil Investigation Results
Test Pits within the Horizontal Extent of Tailings/Impacted Soil
Streamside Tailings Operable Unit - Subarea 1

Test Pit Number	Northing (feet)	Easting (feet)	Elevation at Ground Surface (feet)	Depth to Base of Tailings/Impacted Soil (feet)	Elevation at Base of Tailings/Impacted Soil (feet)
SC1028	746338	1197627	5329.66	0.33	5329.33
SC1029	746331	1197406	5327.91	1.50	5326.41
SC1030	746367	1197263	5327.58	1.83	5325.75

Notes:

1) Horizontal and vertical survey control established by Druveystein, Johnson and Anderson using survey-grade Global Positioning System instrumentation. Survey control use a project datum based on the Montana State Plane Coordinate System, South Zone, NAD27 and NAV29.
2) Depth to base of tailings/impacted soil determined by application of "order-of-magnitude" criteria initially developed during the RI for the SST OU.

APPENDIX D-2

Excavation Depth Calculations

MAXIM
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MEMORANDUM

DATE: January 3, 1997

TO: Jim Ford - MDEQ

FROM: Bill Bucher - Maxim WHB
Mark Teply - Maxim MDT

RE: Technical Memorandum on Statistical Evaluation of Tailings Depth, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area

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Introduction

In our comments on ARCO's submittal regarding its statistical evaluation of tailings/impacted soils dated December 1, 1996, we proposed that we perform an independent statistical evaluation to demonstrate the methods we feel should be employed to determine tailings removal depths. We felt that ARCO's presentation did not correctly address the objective of the evaluation, specifically, to determine a removal depth which will achieve a specified degree of confidence that a specified portion of the tailings are removed. The purpose of this technical memorandum to is to present methods we feel are appropriate using demonstration data sets. These presentations are only intended to present the methods, not to represent actual proposals for depths of tailings to be removed. The actual removal depths for Subarea 1 should be determined using the final data set developed by ARCO for Subarea 1.

This memorandum starts with a presentation of the data set that we selected to demonstrate the statistical evaluation methods. Then we present a method for determining the average tailings removal depth based on an assumption of normally distributed depths and consider the use of the tolerance interval to provide a statistical statement of confidence that some fraction of tailings are removed. These methods are then applied to three different interpretations of the demonstration data set: area-wide statistics, classified data statistics, and geostatistical block estimates.

Description of the Demonstration Data Set

The demonstration data set was compiled from field and analytical measurements made by ARCO during September and October, 1996 near the old Bluebird Smelter (Bluebird) and near Sand Creek. This selection differs from previous ARCO analyses in that it reduces potential bias by considering only observations in which tailings depth is determined by the "order of magnitude break" methodology required by the Record of Decision. Breaks identified in this analysis differ from those identified by ARCO in some

cases. These data have been validated and verified according to this methodology and according to the protocol presented by ARCO and are comparable for analyses.

Table 1 presents the demonstration data set used in our analyses, as well as descriptive statistics. This data set differs from ARCO's data set based on the same samples in that it considers cases where there was no observed tailings break as missing data. Of the 60 pits dug during this sample event, an order of magnitude break was observed in only 35 cases. The majority of the missing data are instances where a break would occur below the deepest sampled depth. This represents a considerable bias in the data set and any estimates presented in this analysis are potentially biased to too shallow a depth.

Derivation of the Removal Depth

This derivation addresses the objective of statistical evaluation in two steps. First, we present a method for determining the excavation depth which will remove a specified fraction of tailings based on the sample distribution of observed depths to tailings. This method is similar to that used to derive average ore grades above cutoff values based on distributions of ore grades in ore reserve estimation (see, for example, Knudsen and Kim, 1978). Given this excavation depth, we employ a tolerance interval approach for stating an excavation depth which will remove a specified fraction of tailings at a specified confidence level. These methods are derived in this section with reference to the area-wide statistics associated with the demonstration data set presented above.

An assumption of this derivation is that the demonstration data provide a unique depth at each sample point and these depths are randomly distributed according to some probability with a mean value, μ, and a standard deviation, σ. Given this distribution of depths of tailings, the average depth of tailings removed is determined by the probability distribution and the removal depth. For material excavated to a depth, D, this value is given by the following expression:

$$\bar{d}_r = \frac{\int_0^D P(x)x\,dx + \int_D^\infty P(x)D\,dx}{\int_0^\infty P(x)\,dx}$$

where: $\bar{d}_r$ = the average depth of tailings removed
x = a measure of depth
D = the removal depth
P(x) = the probability density function of depth.

The first term of the numerator represents tailings which have a depth less than D, the removal depth, and the second term represents tailings which have a depth greater than D. The denominator normalizes the function in the event the probability density function covers values less than zero. Aside from notations and terminology, this equation differs from previous ARCO evaluations in that it allows the removal depth to have any value which permits determination of any given removal fraction, not just the fraction that corresponds to removal to the mean depth.

Given a $\bar{d}_r$, the volume of tailings removed can be calculated through multiplication by the surface area of the extent of tailings, a scalar quantity. The fraction of tailings removed at any D can then be expressed as the ratio of $\bar{d}_r$ to $\bar{d}_a$, where $\bar{d}_a$ is the average depth of tailings removed in the case of total removal of tailings (D equal to infinity). These relationships are important to the final step in determining a D which will correspond to the removal of a specified fraction of tailings.

For the purposes of this demonstration, we will assume that the depths are normally distributed, described by the probability density function:

$$P(x)=\frac{1}{\sqrt{2\pi}}\int e^{-\frac{z^2}{2}}dz$$

where:

$$z=\frac{x-\mu}{\sigma}$$

is the normalized depth variable. This function is then substituted into our equation for $\bar{d}_r$. Integrating the expression for average depth of tailings removed with the substitution of the normalized depth, z, results in the following expression:

$$\bar{d}_r=\frac{\frac{\sigma}{\sqrt{2\pi}}\left(e^{-\frac{z_1^2}{2}}-e^{-\frac{z_2^2}{2}}\right)+\mu\left(N(z_2)-N(z_1)\right)+D\left(1-N(z_2)\right)}{1-N(z_1)}$$

where:
- μ = the mean of the distribution of depths of tailings
- σ = the standard deviation of the distribution of depths of tailings
- z_1 = the normalized depth variable evaluated at x = 0
- z_2 = the normalized depth variable evaluated at x = D
- N(z) = the cumulative normal distribution evaluated at z.

As an example of the determination of a D which will remove a specified fraction of tailings, consider the demonstration data set where μ = 1.72 feet, σ = 0.91 feet. The probability density function for this data set is shown in Figure 1 as the normal approximation presented above. Plotting the average tailings removal depth, $\bar{d}_r$, calculated using this probability density function, versus a continuum of removal depths, D, results in a curve also shown on Figure 1. The average value of depth of tailings removed for D equal infinity, $\bar{d}_a$, is calculated to be 1.72 feet. This graph shows that given any $\bar{d}_r$, which represents a fraction of tailings relative to $\bar{d}_a$, the corresponding D can be determined from these relationships. For example, if it is desired to remove 90% of the tailings, then an average depth of tailings of 0.9 x 1.72 feet = 1.55 feet must be removed. From Figure 1, this corresponds to a removal depth of approximately 2.18 feet. This result can also be computed through use of tables of the z distribution.

To this point we have accomplished the first step in the determination of removal depth, the determination of an excavation depth which will remove a specified fraction of tailings based on the sample distribution of observed depths to tailings. Although the above function describes the relation between removal depth and the average tailings depth removed, it does not provide a statistical statement of confidence in the result. For a chosen level of confidence, the depth of excavation must be increased to allow for error of estimation of the depth from a limited sample size. This is the goal of the second step, employing a tolerance interval approach for stating an excavation depth which will remove a specified fraction of tailings at a specified confidence level.

An interval which, for a given level of confidence, includes a certain percentage of a distribution is called a tolerance interval. The statistical properties of a one-sided tolerance interval based on a normal distribution, and recognized by EPA, were presented by Gerald Lieberman in *Industrial Quality Control*, April 1958 (paper attached). To employ this method, one must select both the desired coverage ($1-\alpha$) or percentage of the distribution to be included in the interval and the desired confidence level (γ). For example, one might wish to determine the upper tolerance limit for 95% coverage with 95% confidence.

The fraction of tailings removed is not equivalent to the coverage used to construct a tolerance interval. Rather, the fraction of tailings removed must be converted to a value on the probability density function of depths and that value used to determine the coverage. For example, from Figure 1, for 90% tailings removal with the demonstration data set, a removal depth of 2.18 feet is approximated. On a normal curve this depth corresponds to a normalized depth of:

$$z=\frac{2.18-1.72}{0.91}=0.51$$

This value of z includes only 70% of the normal curve (one-sided) or 70% coverage. If we desire 95% confidence that 70% of the depths are within the interval, we would then employ the methods of Lieberman using knowledge of the mean value, μ, and standard deviation, σ., and sample size, n. In the case of a large sample size, say n = 400, the large sample approximation presented by Lieberman can be used to calculate a tolerance factor of 0.601. Thus, a depth of 1.72 + 0.601 x 0.91 = 2.27 feet will result in 95% confidence that 90% of the tailings have been removed. This represents a small increase over the depth calculated with no estimation error included (2.18 feet). For a small sample size (n = 35) with 70% coverage and 95% confidence, the tolerance factor is about 0.83 and the removal depth is about 1.72 + 0.83 x 0.91 = 2.48 feet. (Since tables are not readily available for coverages less than 75%, an interpolated value for the tolerance factor was used resulting in an approximate value.) This indicates that an increase in excavation is required to obtain the same confidence level if the sample size is small.

It should be reiterated that the foregoing demonstration is based on evaluation of a normal distribution of depths followed by a tolerance interval method based on a normal distribution. Other distributional models including non-parametric methods should be considered for evaluation of the full set of data to be collected in Subarea 1.

Determination of the Removal Depth Using Classified Data

The derivation presented above used area-wide statistics representing the entire demonstration data set. It is reasonable to expect that these estimates can be improved (i.e., the estimation variance reduced) through classification into meaningful strata. This possibility has been explored by ARCO through the use of mapping units based on observations of deposition and tailings intensity. In this section, we will present a methodology for evaluating statistically significant classes given the mapping units interpreted by ARCO. Once classifications have been determined, we will then apply the methodology derived above for determining removal depth on a strata basis.

The methodology employed entails two steps and is commonly referred to as a "hybrid" classification approach. This approach combines elements of both "unsupervised" and "supervised" classification used in remote sensing applications (Lillesand and Kiefer 1987). Our unsupervised classification uses discriminant analysis to identify statistically significant groupings in the data based solely on the values of our response variable, depth to tailings. Using these results as a guide, we then perform a supervised classification based on the observed mapping units and verify their statistical significance. This approach is useful in areas of complex variability, such as this, where the response variable may behave differently for individual mapping units.

Several discriminant analysis approaches exist which may be useful in unsupervised classifications. For this demonstration, we have used the "K-Means" method which attempts to group the response values into a predefined number of classes (or clusters) based on the relative proximity of data values. This procedure is iterative and continues until there is no significant change in the mean values of the resulting clusters. Using our demonstration data set, we used the K-Means approach to group data into two clusters, the results of which are presented in Table 2 along with descriptive statistics.

Reviewing these clusters, we then performed a supervised classification by combining mapping units representing these clusters and reclassifying the entire data set. This step is, in part, subjective and requires knowledge and confidence in the mapping units. Our interpretation of the clusters and mapping units resulted in the supervised classification presented in Table 3. This classification defines two classes, shallow and deep, in which the deep class includes all abandoned channels (A's) and impoundments (I's) and all high tailings intensities for overbank (O3's) and point bar (B3's) deposits. The shallow class consists of everything else (O1's, O2's, and B2's). An analysis of variance verifies the significance of these depth classes.

When we apply the methodology for determining removal depth results for each depth class, we obtain excavation depths of 2.03 feet and 3.50 feet for the shallow and deep classes, respectively. These values are based on 90% removal of tailings and 95% confidence. If we assume that the number of samples is proportional to the surface area represented by each class, then the average removal depth for the total area is 2.29 feet. This is less than the 2.48 foot removal depth calculated for the global statistical case demonstrating that the classification of the data results in more precise and smaller removal volumes. Larger sample sizes would result in even greater improvements in the removal depth estimates.

It should be noted that this classification of the demonstration data set does not address all concerns we have about the mapping units presented by ARCO. There still remain questions regarding potential bias due to interpretation which require additional information to resolve. It should also be noted that interpretation of the entire Subarea 1 data set may permit a more robust classification exercise. Typically hybrid classification combines similar clusters representing similar mapping units and requires development of training statistics to classify the entire data set. However, given the relative small sample size and the number of mapping units, this would not be practical in this data set. Also, cluster analysis approaches other than K-Means may be more appropriate. However, in a general sense, this step does address the primary concern we had in the statistical evaluation of these units, mainly that resulting classifications be statistically significantly different.

Determination of the Removal Depth Using Geostatistical Estimates

As it was reasonable to expect improved estimates through data classification, it is also reasonable to expect improved estimates through geostatistical methods which account for the spatial correlation of observations. This possibility has been explored by ARCO through interpretation and modeling of variograms developed from a more extensive data set. In this section, we present methods for using geostatistical estimates in determining removal depths.

Our attempts to develop meaningful models of variograms based on the demonstration data set have proven unsuccessful. We believe this result is primarily due to the missing data for pits where the order of magnitude break is deeper than the deepest sample interval analyzed. We speculate that this is artificially lowering the global variance of the data which in effect lowers the sill value and possibly the range of any fitted variogram. Furthermore, the variance for the smallest lag in this data set (100 feet) is relatively close to the sill for the demonstration data set. These conditions combine to create an variogram with virtually no shape to model. Consequently, our remaining discussion makes the assumption that spatial correlation can be modeled from the data, even though the demonstration data set does not support this assumption.

We propose the use of block kriging to develop estimates of mean tailings depth and estimation variance which would in turn be used to determine removal depths following the approach outlined above. Block kriging is typically used in mining applications where point estimation does not provide useful results. Block estimates will be comparable to the classified data results presented above in that they will represent subsets of Subarea 1. In this case these subsets are arbitrary blocks whereas the classified data represented meaningful interpretations. The product of this analysis would then be a map presenting the removal depths on a block basis.

With lack of data, it is premature to state the block size and how it should be discretized; however, it will be driven by the spacing of the available data and construction requirements and capabilities. Also, insertion of additional samples within the existing sampling grids should not be discounted, at this point, if they can improve the estimates. However, the approach presented here provides a general method for the application of any geostatistical results.

References:

Lieberman, G. J., 1958. *Tables for One-Sided Statistical Tolerance Limits*, Industrial Quality Control, April 1958. pp. 7-9.

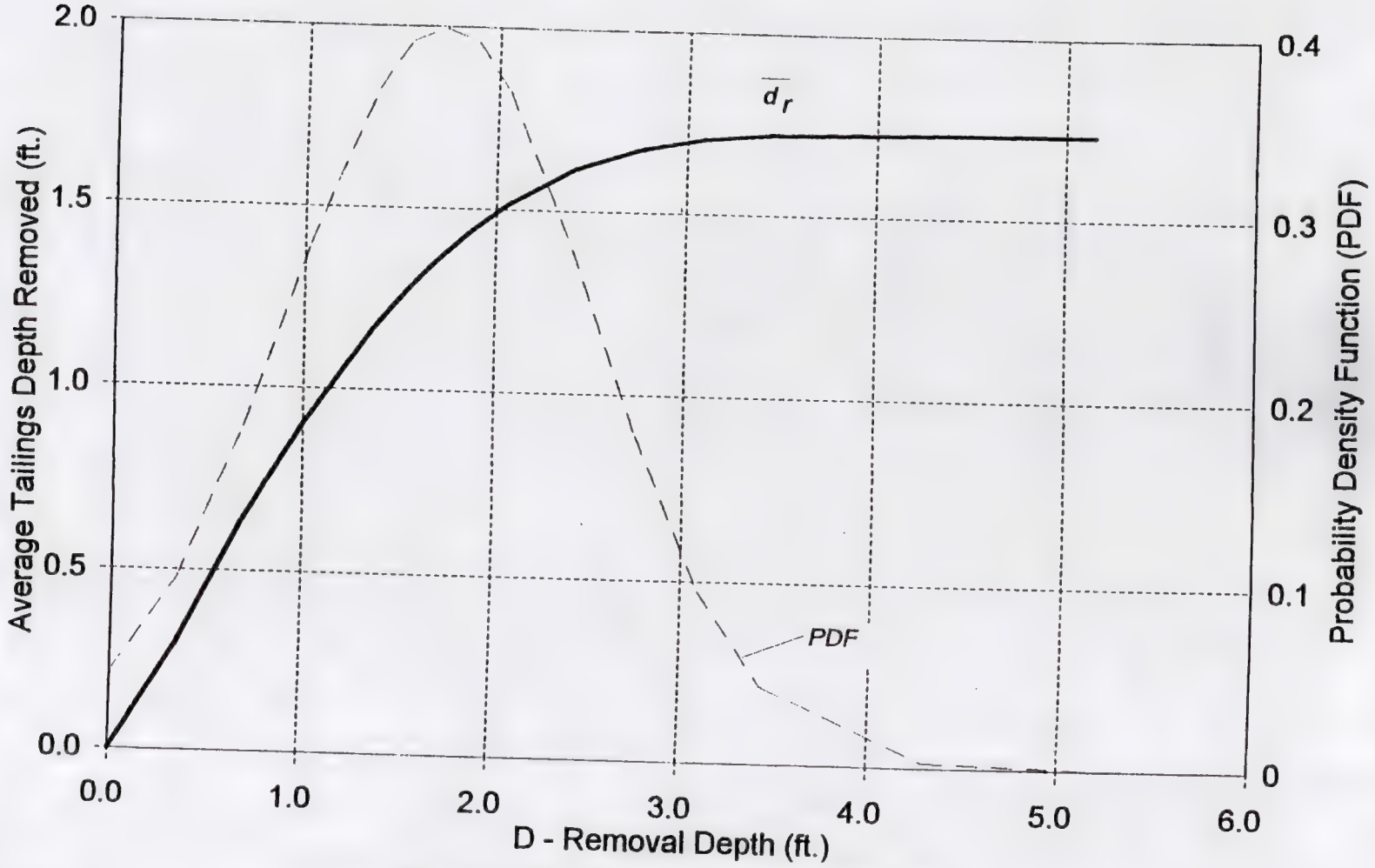
Lillesand, T.M. and R.W. Kiefer, 1987. *Remote Sensing and Image Interpretation*, John Wiley and Sons, New York, 721 pp.

Knudsen, H. P. and Y. C. Kim, 1978. *A Short Course on Geostatistical Ore Reserve Estimation,* University of Arizona, Tucson, Arizona. p. 30.

Attachements:

Figure
Tables
Reprint

FIGURE 1
AVERAGE TAILINGS DEPTH REMOVED



Mean = 1.72 feet, Standard Deviation = 0.91 feet

Table 1: Demonstration Data Set

Statistical Evaluation of Tailings Depth
Streamside Tailings Operable Unit
Silver Bow Creek/Butte Area

Bluebird Study Area		Sand Creek Study Area	
Sample	**Depth of Tailings (ft.)**	**Sample**	**Depth of Tailings (ft.)**
BB1001	2.58	SC1002	1.92
BB1002	0.00	SC1003	2.50
BB1003	1.58	SC1004	4.25
BB1004	1.42	SC1005	1.75
BB1005	1.33	SC1006	2.17
BB1006	1.83	SC1010	2.00
BB1007	2.00	SC1012	2.50
BB1009	1.33	SC1013	1.58
BB1011	0.67	SC1014	2.25
BB1014	1.67	SC1017	1.17
BB1015	2.83	SC1019	1.67
BB1016	0.00	SC1020	1.92
BB1017	3.00	SC1023	1.17
BB1020	0.00	SC1025	1.92
BB1023	1.79	SC1028	0.33
BB1025	3.25	SC1029	1.50
BB1027	0.83	SC1030	1.83
BB1030	1.58		

Descriptive Statistics:

n	35
min	0.00
max	4.25
mean	1.72
median	1.75
s.d.	0.91

Table 2: Demonstration Data Set, Unsupervised Classification

Statistical Evaluation of Tailings Depth
Streamside Tailings Operable Unit
Silver Bow Creek/Butte Area

Cluster Number 1

Sample	Deposition Class (1)	Tailings Intensity (2)	Depth of Tailings (ft.)
BB1002	B	2	0.00
BB1003	O	1	1.58
BB1004	O	1	1.42
BB1005	O	1	1.33
BB1006	O	1	1.83
BB1007	B	2	2.00
BB1009	O	2	1.33
BB1011	O	2	0.67
BB1014	O	3	1.67
BB1016	O	1	0.00
BB1020	O	1	0.00
BB1023	O	1	1.79
BB1027	O	1	0.83
BB1030	O	1	1.58
SC1002	B	3	1.92
SC1005	B	2	1.75
SC1010	I	2	2.00
SC1013	A	3	1.58
SC1017	O	1	1.17
SC1019	O	1	1.67
SC1020	O	1	1.92
SC1023	O	1	1.17
SC1025	O	1	1.92
SC1028	O	1	0.33
SC1029	O	1	1.50
SC1030	O	1	1.83

Descriptive Statistics:

n	26
min	0.00
max	2.00
mean	1.34
median	1.58
s.d.	0.64

Cluster Number 2

Sample	Deposition Class (1)	Tailings Intensity (2)	Depth of Tailings (ft.)
BB1001	B	2	2.58
BB1015	O	3	2.83
BB1017	A	2	3.00
BB1025	A	2	3.25
SC1003	A	3	2.50
SC1004	A	3	4.25
SC1006	B	2	2.17
SC1012	I	2	2.50
SC1014	A	3	2.25

Descriptive Statistics:

n	9
min	2.17
max	4.25
mean	2.81
median	2.58
s.d.	0.64

Notes: - (1) A - Abandoned Channel; B - Point Bar; I - Impoundment; O - Overbank.
(2) 1 - Lowest Intensity; 2- Moderate Intensity; 3 - Highest Intensity.

Table 3: Demonstration Data Set, Supervised Classification

Statistical Evaluation of Tailings Depth
Streamside Tailings Operable Unit
Silver Bow Creek/Butte Area

Shallow Depth Class

Sample	Deposition Class (1)	Tailings Intensity (2)	Depth of Tailings (ft.)
BB1001	B	2	2.58
BB1002	B	2	0.00
BB1003	O	1	1.58
BB1004	O	1	1.42
BB1005	O	1	1.33
BB1006	O	1	1.83
BB1007	B	2	2.00
BB1009	O	2	1.33
BB1011	O	2	0.67
BB1016	O	1	0.00
BB1020	O	1	0.00
BB1023	O	1	1.79
BB1027	O	1	0.83
BB1030	O	1	1.58
SC1005	B	2	1.75
SC1006	B	2	2.17
SC1017	O	1	1.17
SC1019	O	1	1.67
SC1020	O	1	1.92
SC1023	O	1	1.17
SC1025	O	1	1.92
SC1028	O	1	0.33
SC1029	O	1	1.50
SC1030	O	1	1.83

Descriptive Statistics:

n	24
min	0.00
max	2.58
mean	1.35
median	1.54
s.d.	0.71

Deep Depth Class

Sample	Deposition Class (1)	Tailings Intensity (2)	Depth of Tailings (ft.)
BB1014	O	3	1.67
BB1015	O	3	2.83
BB1017	A	2	3.00
BB1025	A	2	3.25
SC1002	B	3	1.92
SC1003	A	3	2.50
SC1004	A	3	4.25
SC1010	I	2	2.00
SC1012	I	2	2.50
SC1013	A	3	1.58
SC1014	A	3	2.25

Descriptive Statistics:

n	11
min	1.58
max	4.25
mean	2.52
median	2.50
s.d.	0.79

Notes: (1) A - Abandoned Channel; B - Point Bar; I - Impoundment; O - Overbank.
(2) 1 - Lowest Intensity; 2- Moderate Intensity; 3 - Highest Intensity.

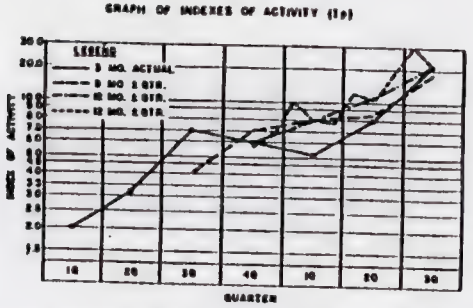


Figure 3—Control Chart for a Selected Stock Item Showing Stock Turnover on a Quarterly Basis

Although the historical average is being used as the center line for the control chart, there is a danger that this average may not be the most desirable level of operations. It is conceivable that the use of a control chart in some instances might tend to result in a loss because of a poor choice of center line. The danger just mentioned might largely be avoided if some good formula were used for reordering during the period for which the average was computed. The control chart, using the activity index as an indicator of stock turnover only serves as an adjunct to some such formula by revealing instances where the formula was not consistently employed or where new developments indicate a revision of the formula might be desirable.

Since the activity formula is comprised of such factors as transactions and quantity, these two factors can be related so as to determine the average quantity per transaction per period. This information can then be used in predicting inventory levels for the coming period by use of the Negative Binomial Distribution.* Other formulas can be developed which will aid in determining reorder points; however it is not the purpose of this article to delve further into this area but only to point out that the use of an activity index aids in evaluating the extent and even "efficiency" of inventory turnover, currently characterized by the sales-inventory ratio, also an indicator of such turnover.

Other similar studies covering various multi-stock inventory situations have been made. The calculated parameters required for control purposes are given in Table I. Reference to this table shows that the average turnover between multi-stock inventories have a considerable range in activity, but the variation remains fairly constant, with the exception of optical equipment, in this case.

*The use of this technique is described by the author with Harry M. Hughes, "Another Look at the Inventory Problem," *Logistic Papers*, George Washington University Logistics Research Project (ONR), 1954.

TABLE I—Summary of Average Stock Turnover for Selected Multi-Stock Inventories, According to the Index of Activity (Log I_p)

Type of Material	Period of Study p-months	Average Activity M (log I_p)	Standard Deviation σ (log I_p)
Brooms, Brushes	12	−0.700000	1.183362
Caskets	24	−0.271062	1.3403342
Clothing	12	−0.814267	1.223482
Drugs	24	−1.760645	1.410910
Electrical Wire	6	−2.137931	1.067250
Hand Tools	12	−1.797306	1.116432
Lamps	12	−2.053770	1.149858
Nuts and Bolts	12	−2.147755	1.350809
Optical Equipment	24	−2.180662	0.840546
Stationery	12	−1.422330	1.185384

Control Chart for a Selected Stock Item

Figure 3 illustrates the use of a control chart for evaluating stock turnover for a selected stock item. In this case, no control limits have been placed on the chart, but if we are to follow the guide-lines used on the multi-stock control chart, we can derive the necessary control limits by using the fact that the average stock turnover for this type of material is $\log I_p = -1.3691589$ with a standard deviation, $\log I_p = 1.3157975$.

Control Limits of I_p	Activity	Action
9.98×10^{-3} — 18.30	Normal	None
18.30—378.6	Fast-Moving	Evaluation
> 378.6	Super-Fast	Look at Stock Status

Obviously, these control limits can easily be denoted on log paper, making it unnecessary to translate the original data into logarithmic activity indexes. The logarithmico-normal characteristics of the underlying probability distribution points to the desirability of using logarithmic-probability paper, in determining the sigma values for any designated risk level. Thus, the control limits can easily be determined by the use of graphical methods.

It will be noted that the control limits really are concerned with the upper bands of the multi-stock inventory covering this particular type of material since the stock item being controlled in this case is a relatively highly active item. Evidently, some further adjustment of the control limits can be made, if the Inventory Manager feels that the region marked by the "Fast-Moving" band (18.30 to 378.6) should call for action rather than evaluation of stock status. In looking at the chart, we find a consistently rising index of activity, and note that the index covering the last quarter has moved into a decision-making area, which probably will call for some stock status-and-demand review.

When dealing with the development of a control chart for specific stock items in a multi-stock inventory, a great amount of flexibility is permitted in determining the control limits for decision-making. In this particular case, the average activity for the total inventory was used in deriving the control limits for a specific stock item. However, the average activity for the item itself could have been used just as well. This would allow for a specific control on a single item, whose activity is evaluated independently of the activity of other stock items of the same type in the total inventory. It becomes quite evident that the control, in this instance, will be much more rigid, and may call for action somewhat earlier than shown in the illustration above.

Summary

This article has served to introduce the concept of controlling the turnover of a multi-stock inventory, using an Index of Activity as a measure of inventory turnover for each of the stock items comprising the total inventory. The control limits are readily calculated using specific risk levels which designate "evaluation" and "action" areas for the Inventory Manager, which means that only a certain number of stock items contained in the multi-stock inventory will be brought to his attention for review and necessary action, depending on the conditions that may arise. The use of a simple formula for determining indexes of activity makes possible a ready and immediate knowledge of the turnover of large multi-stock inventories through the use of an electronic computer.

References

(1) Kahn, Louis B. and Suojanen, Waino W., "Useful Activity Indexes by Inventory Fractionation," *N.A.C.A. Bulletin*, Vol. 36, January 1955, 672-681

(2) Kahn, Louis B., *A Study of the Operational Fractionation of Inventory at NSC, Oakland* (Naval Supply Center, Oakland, Calif., May 1954)

Tables for One-Sided Statistical Tolerance Limits*

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Introduction

The quality of manufactured product is often specified by setting a range, the bounds of which are called tolerance limits. These limits have the property that a certain percentage, $100(1-\alpha)$ percent, of the product may be expected to fall within these limits. If the quality of the items is normally distributed with *known* mean, $\bar{X}'$, and *known* standard deviation, σ', two-sided tolerance limits are formed by adding to and subtracting from $\bar{X}'$ the quantity $K_{\alpha/2}\,\sigma'$, where $K_{\alpha/2}$ is the normal deviate corresponding to $\alpha/2$. An upper one-sided tolerance limit is given by $\bar{X}' + K_\alpha\sigma'$ and a lower one-sided tolerance limit is given by $\bar{X}' - K_\alpha\sigma'$. Unfortunately, in practice, the values $\bar{X}'$ and σ' are rarely known and estimates of these values, $\bar{X}$ and s, respectively, are used. As a result of the use of these estimates, a probability statement, such as, 95 percent of a manufactured product will lie below $\bar{X} + 1.645s$ is not correct, whereas a similar statement involving $\bar{X}' + 1.645\sigma'$ is proper. The quantities $\bar{X}$ and s are random variables, and hence the limit depends upon the particular outcome of the sample. Different samples will lead to different limits. How close these limits are to $\bar{X}' + 1.645\,\sigma'$ depends upon how good the estimates are.

It is evident then that the fraction of the items included between

a. $[\bar{X} - K_{\alpha/2}s,\ \bar{X} + K_{\alpha/2}s]$ for two-sided tolerance limits,

b. $[-\infty,\ \bar{X} + K_\alpha s]$ for an upper one-sided tolerance limit, and

c. $[\bar{X} - K_\alpha s, \infty]$ for a lower one-sided tolerance limit

will not always contain a specified proportion $1-\alpha$ of the manufactured items. However, it is possible to determine constants K such that in a large series of samples from a normal distribution, a fixed proportion γ of the intervals

a. $[\bar{X} - Ks,\ \bar{X} + Ks]$ for two-sided tolerance limits,

b. $[-\infty,\ \bar{X} + Ks]$ for an upper one-sided tolerance limit, and

c. $[\bar{X} - Ks, \infty]$ for a lower one-sided tolerance limit

will include $100(1-\alpha)$ percent or more of the distribution. The finite limits of these intervals are known as statistical tolerance limits. Thus, an upper one-sided statistical tolerance limit is given by $\bar{X} + Ks$ and has the property that the probability is equal to a preassigned value γ that the interval $[-\infty,\ \bar{X} + Ks]$ includes at least a specified proportion $1-\alpha$ of the distribution. Note that in most practical situations γ is usually close to one.

Statistical tolerance intervals should not be confused with confidence intervals for a parameter of the distribution. Confidence limits for the mean of a normal distribution are such that in a given fraction, say 0.95, of the samples from which they are computed, the interval bounded by the limits will include the true mean of the distribution. For confidence interval estimation, 0.95 is also called the confidence coefficient.

Many extensive tables of factors K for *two-sided* tolerance limits have been computed. A. H. Bowker presented such a table [1] and very recently A. Lieberman issued a set of tables[2] which are an extension of Bowker's tables in that they can be used when s is computed from sample sizes other than n. Resnikoff[3] and Mitru[4] computed values of K when σ' is estimated by the average range of subgroups. Tables of factors K for one-sided tolerance limits have never been computed and it is the purpose of this article to present such tables.

Tables of One-Sided Tolerance Limits

Factors K, such that $\bar{X} + Ks$ and $\bar{X} - Ks$ are an upper one-sided tolerance limit and a lower one-sided toler-

*Work done under the sponsorship of the Office of Naval Research under Contract N6onr-281 2a.

TABLE I—Tolerance Factors for Normal Distributions

Factors K such that the probability is γ that at least a proportion $1-\alpha$ of the distribution will be less than $\bar{X} + Ks$ (or greater than $\bar{X} - Ks$), where $\bar{X}$ and s are estimates of the mean and the standard deviation computed from a sample of size n.

n	γ = 0.75					γ = 0.90					γ = 0.95					γ = 0.99				
	0.25	0.10	0.05	0.01	0.001	0.25	0.10	0.05	0.01	0.001	0.25	0.10	0.05	0.01	0.001	0.25	0.10	0.05	0.01	0.001
3	1.464	2.501	3.152	4.396	5.805	2.602	4.258	5.310	7.340	9.651	3.804	6.158	7.655	10.552	13.857					
4	1.256	2.134	2.690	3.726	4.910	1.972	3.187	3.957	5.437	7.128	2.619	4.163	5.145	7.042	9.215					
5	1.152	1.961	2.483	3.421	4.507	1.698	2.742	3.400	4.666	6.112	2.149	3.407	4.202	5.741	7.501					
6	1.087	1.860	2.336	3.243	4.273	1.540	2.494	3.091	4.242	5.556	1.895	2.996	3.707	5.062	6.612	2.849	4.408	5.409	7.334	9.540
7	1.043	1.791	2.250	3.126	4.118	1.435	2.333	2.894	3.972	5.201	1.732	2.755	3.399	4.641	6.061	2.490	3.856	4.730	6.411	8.348
8	1.010	1.740	2.190	3.042	4.008	1.360	2.219	2.755	3.783	4.955	1.617	2.582	3.188	4.353	5.688	2.252	3.496	4.287	5.811	7.566
9	0.984	1.702	2.141	2.977	3.924	1.302	2.133	2.649	3.641	4.772	1.532	2.454	3.031	4.143	5.414	2.085	3.242	3.971	5.389	7.046
10	0.964	1.671	2.103	2.927	3.858	1.257	2.065	2.568	3.532	4.629	1.465	2.355	2.911	3.981	5.203	1.954	3.048	3.739	5.075	6.603
11	0.947	1.646	2.073	2.885	3.804	1.219	2.012	2.503	3.444	4.515	1.411	2.275	2.818	3.852	5.036	1.854	2.897	3.557	4.828	6.284
12	0.933	1.624	2.048	2.851	3.760	1.188	1.966	2.448	3.371	4.420	1.368	2.210	2.736	3.747	4.900	1.771	2.773	3.410	4.633	6.032
13	0.919	1.606	2.026	2.822	3.722	1.162	1.928	2.403	3.310	4.341	1.329	2.155	2.670	3.659	4.787	1.702	2.677	3.290	4.472	5.826
14	0.909	1.591	2.007	2.796	3.690	1.139	1.895	2.363	3.257	4.274	1.296	2.108	2.614	3.585	4.690	1.648	2.592	3.189	4.336	5.651
15	0.899	1.577	1.991	2.778	3.661	1.118	1.868	2.329	3.212	4.215	1.268	2.068	2.566	3.520	4.607	1.596	2.521	3.102	4.224	5.507
16	0.891	1.566	1.977	2.758	3.637	1.101	1.842	2.299	3.172	4.164	1.242	2.032	2.523	3.462	4.530	1.553	2.458	3.028	4.124	5.374
17	0.883	1.554	1.964	2.739	3.615	1.085	1.820	2.272	3.136	4.118	1.220	2.001	2.486	3.415	4.473	1.514	2.405	2.962	4.038	5.260
18	0.878	1.544	1.951	2.723	3.595	1.071	1.800	2.249	3.106	4.078	1.200	1.976	2.453	3.370	4.415	1.481	2.357	2.906	3.961	5.167
19	0.870	1.536	1.942	2.710	3.577	1.058	1.781	2.228	3.078	4.041	1.183	1.949	2.423	3.331	4.364	1.450	2.315	2.855	3.893	5.078
20	0.865	1.528	1.933	2.697	3.561	1.046	1.765	2.208	3.052	4.009	1.167	1.926	2.398	3.295	4.319	1.424	2.275	2.807	3.832	5.003
21	0.859	1.520	1.923	2.686	3.545	1.035	1.750	2.190	3.028	3.979	1.152	1.905	2.374	3.262	4.276	1.397	2.241	2.768	3.776	4.933
22	0.854	1.514	1.916	2.675	3.532	1.025	1.736	2.174	3.007	3.952	1.138	1.887	2.354	3.233	4.238	1.376	2.208	2.729	3.727	4.866
23	0.849	1.508	1.907	2.665	3.520	1.016	1.724	2.159	2.987	3.927	1.126	1.869	2.329	3.206	4.204	1.355	2.179	2.693	3.680	4.806
24	0.845	1.502	1.901	2.656	3.509	1.007	1.712	2.145	2.969	3.904	1.114	1.853	2.309	3.181	4.173	1.334	2.154	2.663	3.638	4.753
25	0.842	1.496	1.895	2.647	3.497	0.999	1.702	2.132	2.952	3.882	1.103	1.838	2.292	3.158	4.145	1.318	2.129	2.632	3.601	4.704
30	0.825	1.475	1.869	2.613	3.454	0.966	1.657	2.080	2.884	3.794	1.059	1.778	2.220	3.064	4.022	1.249	2.029	2.516	3.446	4.500
35	0.813	1.458	1.849	2.588	3.421	0.942	1.623	2.041	2.833	3.730	1.025	1.732	2.166	2.994	3.934	1.195	1.957	2.431	3.334	4.361
40	0.803	1.445	1.834	2.568	3.395	0.923	1.598	2.010	2.793	3.679	0.998	1.697	2.126	2.941	3.868	1.154	1.902	2.365	3.250	4.255
45	0.795	1.435	1.821	2.552	3.375	0.908	1.577	1.986	2.762	3.638	0.978	1.669	2.092	2.897	3.813	1.122	1.857	2.313	3.181	4.164
50	0.788	1.426	1.811	2.538	3.358	0.894	1.560	1.965	2.735	3.604	0.961	1.648	2.065	2.863	3.768	1.096	1.821	2.296	3.124	4.098

ance limit, respectively, for a normal universe, are given in Table I for $n = 3,4,\ldots,25,30,35,40,45,50$; for $\gamma = 0.75$, 0.90, 0.95, 0.99; and for $\alpha = 0.25$, 0.10, 0.05, 0.01, 0.001. $\bar{X}$ is the sample mean, $\bar{X} = (X_1 + X_2 + \ldots + X_n)/n$, and s is the sample standard deviation

$$s = \sqrt{\frac{(X_1 - \bar{X})^2 + (X_2 - \bar{X})^2 + \ldots + (X_n - \bar{X})^2}{(n-1)}}$$

For n greater than 50, the values of K can be obtained using the asymptotic normality property of $\bar{X} + Ks$. With this approximation, K is given by

$$K = \frac{K_\alpha + \sqrt{K_\alpha^2 - ab}}{a}$$

where

$$a = 1 - \frac{K_\gamma^2}{2(n-1)}$$

$$b = K_\alpha^2 - \frac{K_\gamma^2}{n}$$

and K_α and K_γ (which equals $-K_{1-\gamma}$ so that $K_\gamma^2 = K^2_{1-\gamma}$) are the normal deviates corresponding to α and γ respectively, i.e.

$$\int_{x_\alpha}^{\infty} e^{-x^2/2} dx = \alpha$$

and

$$\int_{x_\gamma}^{\infty} e^{-x^2/2} dx = \gamma$$

Example

In the manufacture of forgings used as a terminal block at the end of an airplane wing span, the critical dimension was the lower limit of the slot width. In particular, it was desired that a single lower limit be specified above which it can be assured, with probability 0.95, that at least 99 percent of the slot widths will lie. A sample of 30 forgings were taken and the sample mean and standard deviation were found to be 0.8750 in. and 0.0015 in., respectively. Corresponding to $n = 30$, $\gamma = 0.95$ and $\alpha = 0.01$, a value of $K = 3.064$ is obtained from Table I. The required lower tolerance limit is given by

$$\bar{X} + Ks = 0.8750 - (3.064)(0.0015) = 0.8704 \text{ in.}$$

Construction of the Tables

For the case of a normal distribution with unknown parameters $\bar{X}'$ and σ', exact one-sided tolerance limits may be computed by the following procedure. Let $t_{n-1,\sqrt{n}K_\alpha}$ be a non-central t statistic with n−1 degrees of freedom and non-centrality parameter $\sqrt{n}K_\alpha$, where K_α is defined by

$$\frac{1}{\sqrt{2\pi}} \int_{x_\alpha}^{\infty} e^{-x^2/2} dx = \alpha$$

Determine t_γ such that $P(t_{n-1,\sqrt{n}K_\alpha} > t_\gamma) = 1 - \gamma$. Let $K = t_\gamma/\sqrt{n}$. If $\bar{X}$ and s are the sample mean and the sample standard deviation, respectively, based on a sample $X_1, X_2, \ldots, X_n$, i.e.,

$$\bar{X} = \frac{\Sigma X_i}{n}; \quad s^2 = \frac{\Sigma (X_i - \bar{X})^2}{n-1}$$

then $\bar{X} + Ks$ and $\bar{X} - Ks$ are an upper one-sided tolerance limit and a lower one-sided tolerance limit, respectively. Thus, the probability is γ that at least a proportion $1-\alpha$ of the distribution will be less than $\bar{X} + Ks$ (or greater than $\bar{X} - Ks$).

The value t_γ may be obtained from tables of the distribution of the non-central t statistic. Such tables are those of Johnson & Welch[5] and Resnikoff and Lieberman[6]. The latter tables are perhaps more convenient for this application, and were used in the computation of Table I.

Bibliography

(1) Bowker, Albert H., "Tolerance Limits for Normal Distributions," *Techniques of Statistical Analysis*, edited by Eisenhart, Hastay and Wallis, McGraw-Hill, New York, 1947, Chapter 2

(2) Lieberman, Alfred, "Table for the Determination of Two-sided Tolerance Limits for the Normal Distribution," *Report No. 373-17(55)*, Bureau of Ships, Navy Department, Washington 25, D.C., 20 August 1957

(3) Resnikoff, George J., "Two-sided Tolerance Limits for Normal Distributions Using the Range," *Technical Report No. 33*, Applied Mathematics and Statistics Laboratory, Stanford University, Stanford, California, April 25, 1957

(4) Mitra, S. K., "Tables for Tolerance Limits for a Normal Population Based on Sample Mean and Range or Mean Range," *Journal of the American Statistical Association*, March 1957

(5) Johnson, N. L., and Welch, B. L., "Applications of the Non-central t-Distribution," *Biometrika*, Vol. 31, (1940), p. 362-389

(6) Resnikoff, George J., and Lieberman, Gerald J., *Tables of the Non-central t-Distribution*, Stanford University Press, Stanford, California, (1957), p. 736

Quality Control in the Electric Service Industry*

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It will be the object of this article to speak to the theme of the management viewpoint on the value of quality control with particular reference to the Commonwealth Edison Co., an electric service industry.

Probably not many people are seriously concerned about how an electric utility generates its power or transmits or distributes it. But all of us as individuals are very much concerned that when we flip the switch, the light will come on, or when we poke the plus bar of a computer, it will operate.

Many of us in the electric utility business have a similar attitude toward quality control. Even if we cannot follow the latest quality control theory, we are intensely interested if the method will bring results in the form of better electric service or reduction in cost of operation.

The foundation stone of America's industrial growth is mass production. Our rising standard of living depends on more goods for a given number of hours of labor. This, of course, calls for more production machinery. We in the electric power industry are vitally concerned because our job is to furnish the power for the machine. There is a surprising parallel between the use of electric power by industry and the Federal Reserve Board Index of Industrial Production. We are naturally proud that the use of our service is almost a measure of industrial progress.

What has all this to do with quality control? The skilled craftsman once boasted that no machine could equal his workmanship. This may be true, but the objective of mass production is a uniform product rapidly produced in great quantity and at low cost. The fact that great quantities must be produced makes quality control possible. To keep a product uniform and low in cost makes quality control essential.

Since quality control was first applied in product industries, there is a natural tendency to assume that the method is suitable only to those industries.

A little thought, however, reveals that utilities have been benefiting, indirectly, from the application of quality control to most of the equipment purchased. The electric power industry has about $4 of plant investment for each $1 of annual revenue. Any technique which improves the quality and cuts the cost of equipment benefits the industry, improves service to the customer, and keeps down the price of electricity. In addition, there must be ways that a service industry, with customers numbered in the millions, can make some direct use of these techniques.

I am not in a position to speak for the electric service industry as a whole, but the Commonwealth Edison Company, for one, has at least made a start in the use of quality control methods. Perhaps a few illustrations of some of the problems and the application of these methods to the solution of these problems will demonstrate the possibilities.

Power companies have used oil as an insulator and coolant in electrical equipment for over half a century. This is an excellent material but it has one serious drawback: it is combustible. As our equipment got larger and began to be installed in congested locations, we searched for a material which would be a good insulator and coolant, yet non-combustible. The manufacturers developed one and gave it the name *Askarel*. As with any new product, we sought data which would give, among other things, an indication of its strength as an insulator, its cooling properties, and its aging characteristic. A 10-year engineering research program was set up to collect and evaluate the necessary data. These data, when gathered, seemed to contain meaningless wide variations in values which defied evaluation.

At this point one of our quality control engineers was asked whether or not he could evaluate these data. Using the data already on hand, he was able to give us the specific answers we were seeking.* As a result, a specification limit was set for the

*Presented before the 12th Midwest Quality Control Conference, October 24, 1957, Chicago, Illinois.

*C. L. Matz, "An Application of Statistical Quality Control Techniques to Specification Requirements," *Industrial Quality Control*, Vol. IX, No. 1, July 1952, p. 13.

4/8/68

VARIOGRAM SUMMARY SS7

(1) DATA SET SUMMARY (CIHNLCPTS)

$n = 350$

$\frac{1}{x} = 2.19$

$VAR = 2.59$

$SD = 1.61$

(2) VARIOGRAM SUMMARY (CIHNLKRLB)
CIHNLI2SVG (ATTACHED)
LINEAR MODIFIED
ACTUAL
FIT700 -

Variagram for Subarea 1

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	5 ACTUA	170.0000	5.8128
	5 ACTUA	180.0000	8.8686
	5 ACTUA	190.0000	2.2910
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→ 106 ft - 1.71 variation
<D = 1.31

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5 FITTE	1010.0000	15.1744
5 FITTE	1020.0000	15.3247
5 FITTE	1030.0000	15.4749

5 FITTE	1040.0000	15.6251
5 FITTE	1050.0000	15.7754
5 FITTE	1060.0000	15.9256
5 FITTE	1070.0000	16.0759
5 FITTE	1080.0000	16.2261
5 FITTE	1090.0000	16.3764
5 FITTE	1100.0000	16.5266
5 FITTE	1110.0000	16.6768
5 FITTE	1120.0000	16.8271
5 FITTE	1130.0000	16.9773
5 FITTE	1140.0000	17.1276
5 FITTE	1150.0000	17.2778
5 FITTE	1160.0000	17.4280
5 FITTE	1170.0000	17.5783
5 FITTE	1180.0000	17.7285
5 FITTE	1190.0000	17.8788
5 FITTE	1200.0000	18.0290
5 FITTE	1210.0000	18.1793
5 FITTE	1220.0000	18.3295
5 FITTE	1230.0000	18.4797
5 FITTE	1240.0000	18.6300
5 FITTE	1250.0000	18.7802
5 FITTE	1260.0000	18.9305
5 FITTE	1270.0000	19.0807
5 FITTE	1280.0000	19.2309
5 FITTE	1290.0000	19.3812
5 FITTE	1300.0000	19.5314
5 FITTE	1310.0000	19.6817
5 FITTE	1320.0000	19.8319
5 FITTE	1330.0000	19.9822
5 FITTE	1340.0000	20.1324
5 FITTE	1350.0000	20.2826
5 FITTE	1360.0000	20.4329
5 FITTE	1370.0000	20.5831
5 FITTE	1380.0000	20.7334
5 FITTE	1390.0000	20.8836
5 FITTE	1400.0000	21.0338
5 FITTE	1410.0000	21.1841
5 FITTE	1420.0000	21.3343
5 FITTE	1430.0000	21.4846
5 FITTE	1440.0000	21.6348
5 FITTE	1450.0000	21.7851
5 FITTE	1460.0000	21.9353
5 FITTE	1470.0000	22.0855
5 FITTE	1480.0000	22.2358
5 FITTE	1490.0000	22.3860
5 FITTE	1500.0000	22.5363
5 FITTE	1510.0000	22.6865
5 FITTE	1520.0000	22.8368
5 FITTE	1530.0000	22.9870
5 FITTE	1540.0000	23.1372

5 FITTE	1550.0000	23.2875
5 FITTE	1560.0000	23.4377
5 FITTE	1570.0000	23.5880
5 FITTE	1580.0000	23.7382
5 FITTE	1590.0000	23.8884
5 FITTE	1600.0000	24.0387
5 FITTE	1610.0000	24.1889
5 FITTE	1620.0000	24.3392
5 FITTE	1630.0000	24.4894
5 FITTE	1640.0000	24.6397
5 FITTE	1650.0000	24.7899
5 FITTE	1660.0000	24.9401
5 FITTE	1670.0000	25.0904
5 FITTE	1680.0000	25.2406
5 FITTE	1690.0000	25.3909
5 FITTE	1700.0000	25.5411
5 FITTE	1710.0000	25.6913
5 FITTE	1720.0000	25.8416
5 FITTE	1730.0000	25.9918
5 FITTE	1740.0000	26.1421
5 FITTE	1750.0000	26.2923
5 FITTE	1760.0000	26.4426
5 FITTE	1790.0000	26.8933
5 FITTE	1800.0000	27.0435
5 FITTE	1810.0000	27.1938
5 FITTE	1820.0000	27.3440
5 FITTE	1830.0000	27.4942
5 FITTE	1850.0000	27.7947
5 FITTE	1860.0000	27.9450
5 FITTE	1870.0000	28.0952
5 FITTE	1880.0000	28.2455
5 FITTE	1890.0000	28.3957
5 FITTE	1900.0000	28.5459
5 FITTE	1910.0000	28.6962
5 FITTE	1920.0000	28.8464
5 FITTE	1940.0000	29.1469
5 FITTE	1950.0000	29.2971
5 FITTE	1960.0000	29.4474
5 FITTE	1970.0000	29.5976
5 FITTE	1980.0000	29.7479
5 FITTE	1990.0000	29.8981
5 FITTE	2010.0000	30.1986
5 FITTE	2020.0000	30.3488
5 FITTE	2030.0000	30.4991
5 FITTE	2040.0000	30.6493
5 FITTE	2050.0000	30.7996
5 FITTE	2060.0000	30.9498
5 FITTE	2080.0000	31.2503
5 FITTE	2090.0000	31.4005
5 FITTE	2100.0000	31.5508
5 FITTE	2120.0000	31.8513

5 FITTE	2130.0000	32.0015
5 FITTE	2140.0000	32.1517
5 FITTE	2150.0000	32.3020
5 FITTE	2160.0000	32.4522
5 FITTE	2170.0000	32.6025
5 FITTE	2180.0000	32.7527
5 FITTE	2190.0000	32.9029
5 FITTE	2200.0000	33.0532
5 FITTE	2230.0000	33.5039
5 FITTE	2250.0000	33.8044
5 FITTE	2260.0000	33.9546
5 FITTE	2270.0000	34.1049
5 FITTE	2280.0000	34.2551
5 FITTE	2290.0000	34.4054
5 FITTE	2320.0000	34.8561
5 FITTE	2330.0000	35.0063
5 FITTE	2340.0000	35.1566
5 FITTE	2350.0000	35.3068
5 FITTE	2360.0000	35.4571
5 FITTE	2380.0000	35.7575
5 FITTE	2400.0000	36.0580
5 FITTE	2410.0000	36.2083
5 FITTE	2420.0000	36.3585
5 FITTE	2430.0000	36.5088
5 FITTE	2440.0000	36.6590
5 FITTE	2460.0000	36.9595
5 FITTE	2470.0000	37.1097
5 FITTE	2480.0000	37.2600
5 FITTE	2490.0000	37.4102
5 FITTE	2500.0000	37.5604
5 FITTE	2530.0000	38.0112
5 FITTE	2550.0000	38.3117
5 FITTE	2560.0000	38.4619
5 FITTE	2570.0000	38.6121
5 FITTE	2580.0000	38.7624
5 FITTE	2600.0000	39.0629
5 FITTE	2620.0000	39.3633
5 FITTE	2650.0000	39.8141
5 FITTE	2660.0000	39.9643
5 FITTE	2680.0000	40.2648
5 FITTE	2700.0000	40.5653
5 FITTE	2710.0000	40.7155
5 FITTE	2730.0000	41.0160
5 FITTE	2740.0000	41.1662
5 FITTE	2780.0000	41.7672
5 FITTE	2790.0000	41.9175
5 FITTE	2810.0000	42.2179
5 FITTE	2820.0000	42.3682
5 FITTE	2830.0000	42.5184
5 FITTE	2850.0000	42.8189
5 FITTE	2860.0000	42.9691

5 FITTE	2910.0000	43.7204
5 FITTE	2930.0000	44.0208
5 FITTE	2940.0000	44.1711
5 FITTE	2960.0000	44.4716
5 FITTE	2970.0000	44.6218
5 FITTE	3000.0000	45.0725
5 FITTE	3050.0000	45.8237
5 FITTE	3070.0000	46.1242
5 FITTE	3080.0000	46.2745
5 FITTE	3110.0000	46.7252
5 FITTE	3130.0000	47.0257
5 FITTE	3140.0000	47.1759
5 FITTE	3160.0000	47.4764
5 FITTE	3210.0000	48.2276
5 FITTE	3230.0000	48.5281
5 FITTE	3240.0000	48.6783
5 FITTE	3250.0000	48.8286
5 FITTE	3260.0000	48.9788
5 FITTE	3280.0000	49.2793
5 FITTE	3380.0000	50.7817
5 FITTE	3400.0000	51.0822
5 FITTE	3550.0000	53.3358
5 FITTE	3580.0000	53.7866

WHB
4/12/98

Calculation of Over-Excavation Depth

Method: Memorandum of 1/3/97 to Jim Ford, MDEQ

Database: Subarea I test pits excavated by Titan Environmental, Inc. in 1996-1997 Excluding test pits between I-90 bridges and Stall Storage area.

Statistics: $n = 350$

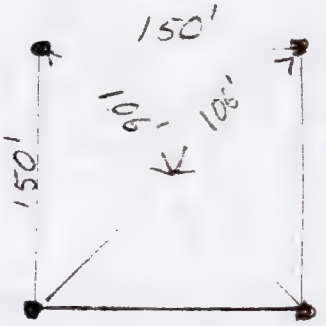
$\mu = 2.19$ ft. (mean depth)

Variogram determined by Maxim based on elevation of base of tailings.

Analysis:

1. Determine variance.

If we assume the test pits are on a 150 ft grid (approximately true), the maximum variance of the elevations between grid points is expected to be the variance at $\frac{150}{\sqrt{2}} = 106$ ft. This variance is $1.7\,ft^2$ and the standard deviation is 1.3 ft



2. Determine the average tailings depth removed as a function of over-excavation depth

$$\bar{d} = \frac{\int_0^D e^{-\frac{x^2}{c}} x\,dx + \int_D^\infty e^{-\frac{x^2}{c}} D\,dx}{\int_0^\infty e^{-\frac{x^2}{c}} dx}$$

where: $z = \frac{X - \mu}{\sigma}$

X = measure of depth (ft)
d = average depth of tailings removed (ft)
D = Removal Depth (ft)
μ = mean (ft)
σ = standard deviation (ft)

Calculate this function for various over-excavation depths: (N_1 = 1st term in numerator, N_2 = 2nd term in numerator, DN = denominator):

Over-Excavation (ft)	D (ft)	N_1	N_2	DN	$\bar{d}$	% Removal
0	2.19	0.5980	1.095	0.9527	1.771	80.9
0.25	2.44	0.7732	1.035	0.9527	1.898	86.7
0.5	2.69	0.9603	0.9455	0.9527	2.000	91.3
0.75	2.94	1.151	0.8336	0.9527	2.083	95.1

By trial and error, the over-excavation depth corresponding to 90% removal is 0.43 ft. or D = 2.62 ft.

3. Determine depth corresponding to 95% confidence the 90% of the tailings have been removed. Use tolerance interval method (Lieberman, 1958).

For 0.45 ft over excavation

$$z = \frac{0.45}{1.31} = 0.3282$$

and $K_\alpha = 0.3282$

For 95% confidence (one-sided)

$z = 1.645$ or $K_\gamma = 1.645$

$$a = 1 - \frac{K_\gamma^2}{2(n-1)} = 1 - \frac{(1.645)^2}{2(349)} = 0.9998$$

$$b = K_\alpha^2 - \frac{K_\gamma^2}{n} = (0.3282)^2 - \frac{(1.645)^2}{350} = 0.1000$$

$$K = \frac{K_\alpha + \sqrt{K_\alpha^2 - ab}}{a}$$

$$= \frac{0.3282 + \sqrt{(0.3282)^2 - 0.9998 \times 0.1000}}{0.9998}$$

$$= 0.4165$$

$$x = \sigma K + \mu$$

$$= 1.31 \times 0.4165 + 2.19$$

$$= 2.74 \text{ ft.}$$

This corresponds to an over-excavation depth of 0.55 ft.

Therefore, over-excavation of about one-half foot should remove 90% of the tailings with 95% confidence.

APPENDIX D-3

Streambank Contaminant Concentration Data

MAXIM
TECHNOLOGIES INC

1610 B Street
P.O. Box 4699
Helena, Montana 59604

(406)443-5210
Fax: (406)449-3729

MEMORANDUM

DATE: October 21, 1997

TO: Andy Young - Department of Environmental Quality

FROM: Michael Cormier mc

CC: Rosemary Rowe - EPA
Bill Bucher - Maxim

RE: Streambank Verification and Horizontal Extent Sampling Results
Streamside Tailings Operable Unit - Remedial Design

Transmitted with this memorandum are maps showing the locations of the streambank and horizontal extent samples along with the analytical results for those samples. We are also transmitting at this time the exploration pit logs for the streambank samples and a copy of the field notes. The horizontal extent logs will be transmitted at a later date.

Streambank and horizontal extent samples were collected and analyzed in accordance with the Sampling and Analysis Plan Addendums prepared for each of the respective investigations. Samples were analyzed for total arsenic, cadmium, copper, lead, and zinc by X-ray florescence and total mercury by graphite furnace atomic absorption.

Streambank sample locations are shown in red and horizontal extent sample locations are shown in blue on the attached maps.

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST - Streambank Sampling

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-10

DESCRIPTIVE LOCATION: Sand Creek area (east), S bank

DATE STARTED: 9/10/97 DATE COMPLETED: 9/10/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 22"

REMARKS:

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-14"	Silty SAND, fine grained, tan to olive gray mottled with brown/orange-gray, appears tailings intermixed	SM	0" 6"	6" 12"	0950 0945
14"-24"	Sandy SILT, dark gray to black, appears tailings impacted		12"	18"	0940
24"	Sandy GRAVEL, subrounded, light gray		18"	24"	0935

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST - Streambank Sampling

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-9

DESCRIPTIVE LOCATION:

DATE STARTED: 9/09/97 DATE COMPLETED: 9/09/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 12"

REMARKS:

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-2"	Silty SAND, fine grained, light brown	SM	0"	6"	1645
2"-12"	Sandy SILT to very silty SAND, fine grained inntermixed with decayed organics, black	SM	6"	12"	1640
	Possible tailings impacted to 12"				

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST - Streambank Sampling

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-8

DESCRIPTIVE LOCATION: E of I-15 overpass, N bank, 1'-1.5' inside bank

DATE STARTED: 9/09/97 DATE COMPLETED: 9/09/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 13"

REMARKS:

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-8"	SAND with minor silts, well graded with lenses of organic materials, black intermixed with light brown to tan, dense root zone to 4"	SW	0" 6"	6" 12"	1425 1420
8"-12"	Silty SAND, fine to medium grained, in decayed organic materials	SP			
	Possible tailings intermixed to 12"				

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST - Streambank Sampling

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-7

DESCRIPTIVE LOCATION: E of Nissler, S of 1S-1223, 1' inside bank

DATE STARTED: 9/09/97 DATE COMPLETED: 9/09/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 11"

REMARKS: S bank, well vegitated

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-5"	Silty SAND, well graded, silt lenses, orange iron staining to light gray, sub-rounded		0" 6"	6" 12"	1300 1255
5"-12"	SILT with minor fine grained sands and decayed organics, black, appears tailings intermixed				

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST - Steambank Sampling

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-6

DESCRIPTIVE LOCATION: Streambank, N Bank, 45' E of 1N-1184

DATE STARTED: 9/09/97 DATE COMPLETED: 9/09/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 24"

REMARKS: W of Demonstration Project I, 1' inside N bank

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-4"	Silty SAND, fine grained, light brown, dense root zone to 4"	OL-ML	0" 6"	6" 12"	0935 0930
4"-19"	SAND, well graded, light brown (clean sand)	SW	12"	18"	0925
19"-24"	Very silty SAND, fine grained, black, possible tailings intermix	ML	18"	24"	0920

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST - Streambank Sampling

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-5

DESCRIPTIVE LOCATION: S of town pump parking lot, N bank

DATE STARTED: 9/10/97 DATE COMPLETED: 9/10/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 15"

REMARKS:

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-6"	Very silty SAND, fine grained, in heavily organic root zone, tan with mottled gold, iron stained	OL-SM	0"	6"	1110
6"-18"	GRAVEL and COBBLES, intermixed in fine sand, gray to dark gray mottled with orange/gold, iron stained fines, cobbles to approximately 6" diameter, gravel/cobble fraction approximately 80	GP	6" 12"	12" 18"	1105 1100

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST - Steambank Sampling

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-4/Duplicate VSB-11 VS

DESCRIPTIVE LOCATION: At roadcrossing, E of Rocker, S bank

DATE STARTED: 9/10/97 DATE COMPLETED: 9/10/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 12"

REMARKS:

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-18"	SILT with minor fine sands, dark gray to mottled black, tailings intermix possible	SM	0" 6"	6" 12"	1555 1550
18"	SAND, medium to coarse grained	SP			
	Duplicate sample VSB-11		6"	12"	1610

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST - Streambank Samples

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-1/Duplicate VSB-12

DESCRIPTIVE LOCATION: N bank, at E county road crossing, 1' inside bank

DATE STARTED: 9/11/97 DATE COMPLETED: 9/11/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 11"

REMARKS:

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-5"	Silty SAND, very fine grained, dark gray, 20%-25% organics	ML-SM	0"	6"	1410
5"-12"	Sandy SILT, dark gray spotted with black decayed organic zones, 10-20% organics		6"	12"	1405
15"	SAND/GRAVEL, (felt by probing)				
	Duplicate sample VSB-12		6"	12"	1430

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-3

DESCRIPTIVE LOCATION: W of Bluebird, S bank

DATE STARTED: 9/10/97 DATE COMPLETED: 9/10/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 12"

REMARKS: 25' W of 1S-1106

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-10"	Silty SAND, olive gray mottled with black and orange iron staining, minor silt lenses, fine grained sand, tailings intermixed	SP-SM	0" 6"	6" 12"	1700 1655
10"-12"	Sandy SILT in decayed black organics, possible tailings impacted	SM			

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST - Streambank sampling

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-2

DESCRIPTIVE LOCATION: E of Bluebird, S bank

DATE STARTED: 9/10/97 DATE COMPLETED: 9/10/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 12"

REMARKS:

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-12"	Silty SAND, fine grained, olive gray, possible tailings intermixed	SM-SP	0"	6"	1745
	Rocky soils encountered with shovel at approximately 18"		6"	12"	1740

MAXIM TECHNOLOGIES, INC.
LOG OF EXPLORATION TEST PIT

JOB NO: 9731701.150 PROJECT NAME: SST - Streambank Sampling

STATE: MT COUNTY: Silver Bow LOGGED BY: Scott Colvin TEST PIT NO.: VSB-0

DESCRIPTIVE LOCATION: E of I-15/90 overpass, S bank, 12" inside bank

DATE STARTED: 9/11/97 DATE COMPLETED: 9/11/97 EXCAVATION COMPANY

GROUNDWATER ELEVATION: 19"

REMARKS: 20' E of 1S-1003

Depth	Classification and Description	Sample Symbol	Sample Depth		Time
			FROM	TO	
0"-5"	Silty SAND, fine grained sand, dark gray	SM	0"	6"	13:25
5"-18"	Sandy SILT, dark gray mottled with black and orange iron staining below 15" depth, intermixed with 10-20% organics	SM-SP	6" 12"	12" 18"	13:20 13:15

9/97 S. Collins & Maxim
J. Davidson

Cloudy-cool (60°) Team @ 1730

0745 Met Dave Johnson (Titan) at Town Pumps, prep for sampling at Sand Creek:

Verification Sample VS-116:

Sand CK, S. Bank, 95' S. of test pit SC 1029, 20'55" 05Be at area of green stained surface algae

Duplicate sample taken, labeled VS-117 @ 6"-12" zone

VS-116		
	0"-6"	0840
	6"-12"	0835
	12"-18"	0830
VS-117	6"-12"	0900

Titan obtained split of sample pit

Well registered cover, extensive root zone to ~6" depth

Lithology:

0"-1" SILT, SL; sandy in organics, prominent green (copper oxide) stained, green possible tailings intermix

1"-15" - sandy SILT, v moist green gray to dark gray, slight tan/brown mottled, appears tailings intermix between 10"-15"

15"-18" silty SAND, brown to tan, well graded, slightly rounded

Photo - marked to extent of boundary staking - tailings present at ~15" depth

STREAM BANK SAMPLING:

VSB-10, located along S. bank E. of Sand CK, ~35' N of test pit 15-1307

well vegitated hydric soils intermixed with rocks/organics to ± 12" depth
SWL = 22", sampled ± 6"
inside edge of streambank
0"-6" = 0950
6"-12" = 0945
12"-18" = 0940
18"-29" = 0935

Lithology:

0"-14" silty SAND, fine grained tan to olive grey mottled w brown/orange-gray

14"-24" sandy SILT, dark gray to black, appears hydric impacted

24"- sandy GRAVEL, subrounded clean light grey to brown

Photo - 5% well vegitated w grasses to ±20' S of bank

Hike to Streambank Sampling location USB-5 S. of Town Dump near King Rd, along N. bank. Sampled ± 1' inside bank @ 11 Common-site

0"-6" @ 1110
6"-12" 1105
12"-18" 1100

Lithology:
0"-6" silty SAND fine grained in heavy organics, OLIVE, mottled gold from
6"-18" - Cobbled GRAVEL, cobbled to ± 6", intermixed in fine well vegitated bank 3' N to parking lot ± 90 NW SBC
Sand, grey to dk grey mottled w orange/gold iron staining
cobble/gravel fraction ± 80%
SWL = 15"

Photo

... to S. bank area W of Demo I and E of RR crossing:

IS-1197 - observed well stained tailings to 18" from 12", edge appears on toe of slope 80' W of RR crossing (UP line)

IN-5004 - no tailings observed beyond 15' S of test pit; set boundary stake

IN-5010 - no tailings observed beyond 15' S of test pit; set boundary

No test pits E of IN-5010

test trenches in large Pond between RR grade 200' E of IN-5010 revealed questionable tailings, selected verification samples in slight silty mottled area: VS-118:
60' S of E Rail grade

0"-6" = 1495
6"-12" = 1450
12"-18" = 1455

(set boundary stake 110' E of VS-118 in silty SAND soils w no visible staining

VS-118 Lithology:
well vegetated swamp grasses
0"-4" - organics, black in sandy SILT

4"-10" sandy SILT, sli sandy olive gray, sli mottling with dark gray & gold (iron stain)

10"-18" silty SAND w olive SILT lenses, fine to med grained sand, tan with mottled iron staining

H2O @ 15" (s/w recovery)

TYPICAL OBSERVED SOIL SAMPLES

Streambank Sampling: VSB-4

well vegetated banks located
~~N 52° W~~ based 50' E of county road

0"-6" 1555
6"-12" 1550

X Duplicate sample taken
labeled VSB-11 @ 6"-12"

Lithology: organic/root zone
well established to ~4"

0"-18" SILT w minor
fine sand to dark grey w
black mottling

18" - med to coarse sand
SWL = 12"

- VSB-4 located on S. bank
±1' inside bank

VSB-3 located 25' W of
15-1106 & 1' inside bank, on
S. Stream bank

0"-6" 1700
6"-12" ~~1700~~ 1655

TITAN OBTAINED A SPLIT
SAMPLE OF VSB-3

Lithology:
0"-10" = SILTY SAND, olive
grey mottled with black &
orange gold staining, minor
SILT lenses, fine grained sand
10"-12" sandy SILT w
decayed organics, black

SWL = ~12"

PHOTO

VSB-2: TOP OF 15-1078
located on S bank, W bank
stretch is unvegitated, sampled
1' from edge of stream.

0"-6" 1745
6"-12" 1740

Well vegitated bank to ~10' ±
extensive root zone to ~6"

Lithology - (SWC = 12")

0"-12" - silty SAND fine grained, olive gray

Hand-Lady auger terminated with shovel at 18"

Photo

1800 - off site - Rain

9/11/97 S. Gowan & S Staley
J Davidson
cloudy - cool 60- °

0800 - on-site @ Rocklin meeting place

0830 - arrive at Peregrine Trail verification site, W. of county road crossing (E end), N side of creek D. Johnson on site

1N-1040 - set stake ± 95' N of 15" S of RR toe, RR embankment composed of rock - imported surface soils N of stake

1N-1041 - set stake ~25' N of edge of tailings retaining - iron stained & gray silts

1N-1042 - observed imported soils/tailings to be N of test pit # set laumer stake - mounded surface disturbance

w impacted soils on fan/toe of slide, slide at top of elevation rise

LN-1044 - test pit located at crest of hill - old channel lower elevation to N has well defined tailings to toe of slope 75' to North of set boundary stake (LN-1044 shows 0 tailings)

LN-1046 - set stake at toe of slope (well defined) 135' N of suspect tailings impacted set VS-119 ± 15' S of SL boundary stake (well defined tailings at 55' S of VS-119

LN-1049 - (.05' tailings) - located at toe of slope - Disturbed ground upslope 210' N of LN-1049 - pockets of well defined boundary to E of LN-1046

mounded tailings appear to have been placed by means other than stream flow (man-caused) - spotted deposits between native/non impacted areas, 4 old roads cut in area

1000 Arrive at Stukpyard

Stn GPS mapping

Gong down slope on N bank sequenced N-LN → downstream

- File # R091116A
N-LN to N-4N Cross
+ VS-101 point

Move to early RD to west
N-5N to N-12N
File # R091116B
+ VS-103 not labeled
in GPS omit - closed

E of Bluebird - S bank:

V-7-155
+ VS-104
file # R091117A

Surveyed stream bank
VSB-2
file # R091117B

1230
Move to S bank below I-15/40 overpass - survey V-15 & V-65, VS-102, VSB-0
R091118A

SAMPLE STREAM BANKS:

VSB-0: S. Bank, ~1.5' inside bank & 20' E of I5-102B

well vegitated, no zone to 6" depth

Lithology -

0"-5" silty SAND, brown grained, dk gray

5"-18" sandy SILT, dark gray, mottled w black and orange iron staining below 15" top, organics intermixed to 18" (I 10-20")

SWL = 19"

PHOTO

0"-6"	@	1325
6"-12"		1320
12"-18"		1315

VSB-1: located on N. bank, I 12' inside bank edge, & ~95' E of & county road crossing (N of I-15/40 overpass), well vegitated bank to grass extending I 20' N

0"-6" @ 1410
6"-12" @ 1405 Duplicate = 1430

Lithology:
0"-5" = sandy SAND, v. fine grained, dk gray / extensive root zone to 4-5", ± 20% - 25% organics
5"-12" = sandy SILT, dark gray spotted w/ black decayed organics, organics ± 10-20%

Duplicate sample obtained from 6", labelled VSB-12 @ 1430

TITAN collected split samples

SWL = 1/-12"

SAND/Gravels fill + w/ shovel @ ~15" depth

photo

GPS VSB-1 = #RW1120A

1515 Move to Sand creek area to investigate potential pairings S. of RR grade, E of Sand Ck in wetland area

digging in wetland area in areas potential for peat to terminate below 6" depth

Verification Sample VS-119

0"-6" 1545 Discarded - Peat
6"-12" 1540

VS-119 located across rail grade from 15-130' to + pit, ± 30' S of RR grade toe.
- Swamp grasses below 1-2" surface water
- decantamated digging shovel & removed core of peat to ~5" ?"

Composed 2nd core between 6" & 12"

VS-119 B ± 180' W. of county culvert (RR)

Lithology:

0"-6" = Peat (OL) organics appear ±90% in silt, dk gray to black

6"-12" sandy SILT, light gray to gray, mottled w/ rust/light brown/orange gray, possible perhaps intensity

TIMBW obtained split of 6"-12" sample

PHOTO

culvert across RR grade is skewing, culvert is 29" Ø

Testing 10' EW culvert NW of 20' SW RR grade for:
9" mulch/organics over 8" CLAY, silty, gray & 1" Top. 12" Below 12" depth appears silts
Scene 99 in US-119

US 120 ±325'S of RR

± 23' E of small creek & culvert grade at base of slope, on dry area of wet/veg. swamp grade

0"-6" 1650
6"-12" 1645
12"-18" 1640

Lithology:

0"-4" - SILTY LOAM -, dk brown & dk gray

4"-14" sandy SILT to silty SAND, fine grained, light grey, mottled to orange/gold iron staining

14"-17" - silty CLAY, sandy, olive-gray

(9-12-14 = possible tailings intermix)

set boundary stake at E end in sticky sand of gravel soils ± 135' E of culvert ± 150' S of RR grade

Swamp water too deep adjacent to RR grade to see for observations

set W boundary stake at W edge of swamp area - surface water too deep to verify extent - boundary of suspected tailings W of VS-119

1715 off-site @ Sandick, light rain

D. Johnson of Titan obtained split of VS-120, 6"-12"

9/12/14 S. Corwin
cloudy, cool ± Pam Teas
0930 met Dave @ trailer
split out C-D-C's, Joe will deliver samples to Alco Analytics & Bill Hopp Labs (Wasilla)

0930 S. Corwin en site at county road entrance for Rocker - surveying (GPS): W-168-295 & cached

20912145A, includes
Nested points: VSB-3, VSB-4, VS-105, VS-106, VS-107, VS-108
1030 Rain
Move to W Bank Rocker Sluice
W-13 & 15 N
20912164
1100 Rain stops

VSB-5 GPS =
F.C # R091217A

1130 obtain & switch batteries
on GPS, move to site
N Bank, west of Dam I:

V-16-29 N
+ nested points VSB-6,
VS-109, VS-111 (VS-110 is dry & VS-108)
R091217B file

Move to S bank, Fair Rail
crossing: # R091218A

V-30-33 S
+ nested point VS-118

Move to E Nissler area:

V25-30 N + nested
points VS-112, VSB-7,
VS-113
R091218B

STAKE set FC-1 & VS-114,
set ext tie & recite mark
description (RK tree - not surveyed,
appears to be not flood plain
in origin
- Drive to W side of I-15 overpass,
survey points VSB-8,
VS-115, VS-119
R091219A file

- Drive to VSB-9 Send
Creek Area:
Survey Points
V-34-39S, plus
nested points VS-116 #
VSB-10 # VS-117 & VS-120,
(all in middle, are not nested)
file
R091220A

Move to VSB-9
file # R091221A
1530 depart site

Maxim
200 South 25th Street
P O Box 30615
Billings, MT 59107
(406) 248-9161
FAX (406) 248-9282

TECHNICAL REPORT

REPORT TO: ATTN: MIKE CORMIER
MAXIM TECHNOLOGIES, INC.
P O BOX 4699
HELENA MT 59604

DATE: September 30, 1997
JOB NUMBER: 87-911
SHEET: 1 of 2
INVOICE NO.: G7934

REPORT OF: Soil Analysis - SST-OV/Streambank - Platinum #5609702728.06

SAMPLE IDENTIFICATION:

On September 12, 1997, these soil samples (laboratory numbers 187290 through 187319) were received in our laboratory for analysis. The tests were conducted in accordance with SW-846 *"Test Methods for Evaluating Solid Waste"*, 3rd Edition, updates I, II, IIA, IIB.

The condition of the samples upon receipt at the laboratory is noted on the attached sample receipt checklist. Chain of custody documentation is enclosed.

The test results are shown on the following pages.

A < sign indicates the value reported was the practical quantitation limit for this sample using the method described. Concentrations of analyte, if present, below this were not quantifiable.

Reviewed by Kathleen A Ka

Attachments: Chain of Custody
Sample Receipt Checklist

caj

As a mutual protection to clients, the public and ourselves, all reports are submitted as the confidential property of our clients and authorization for publication of statements, conclusions or extracts from or regarding our reports is reserved pending our written approval. Test results apply specifically to the samples tested only. The entire report shall not be reproduced, except in full, without the written approval of the laboratory.

LABORATORY SAMPLE REPORT

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Sample Location: SST-OV/STREAMBANK 5609702728-06
Sample Date: 09/09/97
Collected by: SCOTT COLVIN

Laboratory Number	Sample Identity	Mercury Dry Basis Measured Value	Units	Method Number	Date Analyzed
187290	VSB-6 0-6"	4.6	mg/kg	7471	09/26/97
187291	VSB-6 6-12"	0.5	mg/kg	7471	09/26/97
187292	VSB-6 12-18"	1.2	mg/kg	7471	09/26/97
187293	VSB-6 18-24"	2.1	mg/kg	7471	09/26/97
187294	VSB-7 0-6"	2.3	mg/kg	7471	09/26/97
187295	VSB-7 6-12"	3.7	mg/kg	7471	09/26/97
187296	VSB-8 0-6"	2.3	mg/kg	7471	09/26/97
187297	VSB-8 6-12"	3.8	mg/kg	7471	09/26/97
187298	VSB-9 0-6"	3.6	mg/kg	7471	09/26/97
187299	VSB-9 6-12"	4.1	mg/kg	7471	09/26/97
187300	VSB-10 0-6"	3.5	mg/kg	7471	09/26/97
187301	VSB-10 6-12"	5.0	mg/kg	7471	09/26/97
187302	VSB-10 12-18"	7.6	mg/kg	7471	09/26/97
187303	VSB-10 18-24"	5.0	mg/kg	7471	09/26/97
187304	VSB-5 0-6"	3.3	mg/kg	7471	09/26/97
187305	VSB-5 6-12"	0.3	mg/kg	7471	09/26/97
187306	VSB-5 12-18"	0.3	mg/kg	7471	09/26/97
187307	VSB-4 0-6"	5.8	mg/kg	7471	09/26/97
187308	VSB-4 6-12"	4.6	mg/kg	7471	09/26/97
187309	VSB-3 0-6"	4.7	mg/kg	7471	09/26/97
187310	VSB-3 6-12"	4.9	mg/kg	7471	09/26/97
187311	VSB-2 0-6"	6.7	mg/kg	7471	09/26/97
187312	VSB-2 6-12"	6.9	mg/kg	7471	09/26/97
187313	VSB-0 0-6"	10.3	mg/kg	7471	09/26/97
187314	VSB-0 6-12"	7.3	mg/kg	7471	09/26/97
187315	VSB-0 12-18"	6.0	mg/kg	7471	09/26/97
187316	VSB-1 0-6"	10.1	mg/kg	7471	09/26/97
187317	VSB-1 6-12"	6.1	mg/kg	7471	09/26/97
187318	VSB-12 6-12"	4.8	mg/kg	7471	09/26/97
187319	VSB-11 6-12"	5.8	mg/kg	7471	09/26/97
187322	MATRIX SPIKE 187290 VSB-6	109	% [86-120]	7471	09/26/97
187323	DUPLICATE 187297 VSB-8	4.3	mg/kg	7471	09/26/97
187324	MATRIX SPIKE 187311 VSB-2	107	% [86-120]	7471	09/26/97
187325	DUPLICATE 187316 VSB-1	9.4	mg/kg	7471	09/26/97
187326	MATRIX SPIKE 187302 VSB-1	114	% [86-120]	7471	09/26/97
187327	DUPLICATE 187307 VSB-4	6.2	mg/kg	7471	09/26/97

ATTACHMENTS

CHAIN OF CUSTODY RECORD

MAXIM TECHNOLOGIES INC
600 South 25th Street
Billings, Montana 59101
Phone (406) 248-9161 • Fax (406) 248-9282

SST-00/Streambank
Project or Site Name

560920272B-06
Project Number

Scott Colvin
Sampler Name (Printed)

Contact Name: MAXIM
Report to (Firm or Agency): Helena
Address: Scott Colvin
Sampler Signature

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO OF CONTAINERS	ANALYSIS REQUIRED: Mercury	NOTES	LAB NUMBER
9/9/97	0935	VSB-6, 0"-6"	Comp	Soil	1	X	Cooled	187890
"	0930	VSB-6, 6"-12"	"	"	1	X		91
"	0925	VSB-6, 12"-18"	"	"	1	X		92
"	0920	VSB-6, 18"-24"	"	"	1	X		93
"	1300	VSB-7, 0"-6"	"	"	1	X	Mod Rec'd	94
"	1255	VSB-7, 6"-12"	"	"	1	X		95
"	1425	VSB-8, 0"-6"	"	"	1	X		96
"	1420	VSB-8, 6"-12"	"	"	1	X		97
"	1645	VSB-9, 0"-6"	"	"	1	X		98
V	1640	VSB-9, 6"-17"	"	"	1	X		99

7 Sample

Relinquished by: Scott Colvin — Date 9/12/97 — Time 0800 — Received by: Joey Davidson

Relinquished by: Joey Davidson — Date 9/12/97 — Time 1330 — Received by: [signature]

Relinquished by: [signature] VSB-7 6-10" only — Date 9/15/97 — Time 1320 — Received by: UPS

Relinquished by: — Date — Time — Received by:

Remarks
Mercury Analysis by Graphite Furnace

Cooler temp 3.2°C & 1.6°C

08/30/97 TUE 08:02 FAX 406 MAXIM-- 0004

CHAIN OF CUSTODY RECORD

MAXIM TECHNOLOGIES INC

600 South 25th Street
Billings, Montana 59101
Phone (406) 248-9161 • Fax (406) 248-9282

SST-04/Streambank
Project or Site Name

560702728-06
Project Number

Scott Colvin
Sampler Name (Printed)

Mike Garmier
Contact Name

Maxim
Report to (Firm or Agency)

Helena
Address

Sampler Signature

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO OF CONTAINERS	ANALYSIS REQUIRED: Mercury	NOTES	LAB NUMBER
9/10/97	0950	VSB-10, 0"-6"	Comp	Soil	1	X	Cooled	18733
	0945	VSB-10, 6"-12"			1	X		01
	0940	VSB-10, 12"-18"			1	X		02
	0935	VSB-10, 18"-24"			1	X		03
	1110	VSB-5, 0"-6"			1	X		04
	1105	VSB-5, 6"-12"			1	X		05
	1100	VSB-5, 12"-18"			1	X		06
	1555	VSB-4, 0"-6"			1	X		07
	1550	VSB-4, 6"-12"			1	X	Not Rec'd	08
	1200	VSB-3, 0"-6"			1	X		09

Relinquished by	Date	Time	Received by
Scott Colvin	9/12/97	0830	Joey Davidson
Joey Davidson	9/12/97	1320	A Cleveland
Relinquished by:	Date	Time	Received by:
Relinquished by:	Date	Time	Received by

Remarks:
Mercury Analysis by Graphite furnace

Cooler temp 3.2°C & 1.6°C

09/30/97 TUE 09:02 FAX 406 MAXIM-- 005

CHAIN OF CUSTODY RECORD

MAXIM TECHNOLOGIES INC

600 South 25th Street
Billings, Montana 59101
Phone (406) 248-9161 • Fax (406) 248-9282

SST-Ch/Streambank
Project or Site Name

560702728-06
Project Number

Scott Colvin
Sampler Name (Printed)

Mike Clinch
Contact Name

Maxim
Report to (Firm or Agency)

Helena
Address

Scott Colvin
Sampler Signature

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO OF CONTAINERS	ANALYSIS REQUIRED: Mercury	NOTES	LAB NUMBER
10/97	1655	VSB-3, 6"-12"	comp	Soil	1	X	Cooled	187310
	1745	VSB-2, 0"-6"			1	X		11
	1740	VSB-2, 6"-12"			1	X		12
11/97	1325	VSB-0, 0"-6"			1	X		13
	1320	VSB-0, 6"-12"			1	X		14
	1315	VSB-0, 12"-18"			1	X		15
	1410	VSB-1, 0"-6"			1	X		16
	1405	VSB-1, 6"-12"			1	X		17
	1430	VSB-12, 6"-12"			1	X		18
10/97	1610	VSB-11, 6"-12"			1	X		19

Relinquished by: Scott Colvin — Date: 9/12/97 — Time: 0800 — Received by: Jay Davis

Relinquished by: Jay Davis — Date: 9/12/97 — Time: 1330 — Received by: H.E. Blueland

Relinquished by: H.E. Blueland — VSB-11 6-12" only — Date: 9/14/97 — Time: 1300 — Received by: UPS

Relinquished by — Date — Time — Received by

Remarks:
Mercury Analysis by Graphite furnace

Cooler temp 3.2°C & 1.6°C

08/30/97 TUE 09:03 FAX 406 MAXIM-- 006

CHAIN OF CUSTODY RECORD

MAXIM TECHNOLOGIES INC

600 South 25th Street
Billings, Montana 59101
Phone (406) 248-9161 • Fax (406) 248-9282

Project or Site Name

Project Number

Sampler Name (Printed)

Contact Name

Report to (Firm or Agency)

Address

Sampler Signature

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED	NOTES	LAB NUMBER
9/9/97	1255	VSB-7, 6"-12"			18322	MS 187290	VSB-6 0-6" 9/9 0935	
9/10/97	1610	VSB-11, 6"-12"			23	Dup 187297	VSB-8 6-12" 9/9 1400	
					24	MS 187311	VSB-2 0-6" 9/10 1745	
					25	Dup 187316	VSB-1 0-6" 9/11 1410	
		Table Shipped but do not Analyze Perkins 9/12			26	MS 187302	VSB-10 12-18" 9/10 0940	
					27	Dup [illegible]	18307	
							VSB-4 0-6" 9/10 1555	

Relinquished by:	Date	Time	Received by:	Remarks:
Relinquished by:	Date	Time	Received by:	
Relinquished by:	Date	Time	Received by:	
Relinquished by:	Date	Time	Received by:	

4

08/30/97 TUE 08:03 FAX 406 406 MAXIM-- 007

MAXIM TECHNOLOGIES INC

SAMPLE RECEIPT CHECKLIST

Client Name: N. Helena

Project: SST-OU / Streambank

Laboratory number(s): 187290-323

Checklist completed by: GB 9/12 (Initials / Date)

Date/Time Received: 9/12/97 13 (Date Time)

Received by: M Blenelaire

Carrier name: Hand Delivered

Sample Type: Soil

		YES	NO
1.	Shipping container in good condition?	✓	
2.	Custody seals present on shipping container?	✓	
3.	Condition: Intact ✓ Broken		
4.	Chain of custody present?	✓	
5.	Chain of custody signed when relinquished and received?	✓	
6.	Chain of custody agrees with sample labels?		✓
7.	Custody seals on sample bottles?		✓
8.	Condition: Intact ____ Broken ____		
9.	Samples in proper container/bottle?	✓	
10.	Samples intact?	✓	
11.	Sufficient sample volume for indicated test?	✓	
12.	VOA vials have zero headspace?	NA	NA
13.	Trip Blank received?		✓
14.	Ice/Frozen Blue Ice present in shipping container? (circle one)	✓	
15.	Container temperature 1. 3.2°C 2. 1.6°C 3. ____		

		YES	NO
16.	All samples rec'd within holding time?	✓	
	Preservation		
17.	pH check performed by: ____		
18.	Metals bottle(s) pH <2?	NA	
19.	Nutrient bottle(s) pH <2?		
20.	Cyanide bottle(s) pH >12?		
21.	Sulfide bottle(s) pH >9?		
22.	Oil & grease bottle(s) pH <2?		
23.	TOC bottle(s) pH <2?		
24.	DRO/418.1 bottle(s) pH <2?		
25.	Phenolics bottle(s) pH <2?		
26.	Volatiles (VOA) pH <2? (VOA pH checked by analyst)	NA	
27.	Client contacted?		
28.	Person contacted ____		
29.	Date contacted ____		
30.	Contacted by ____		
31.	Regarding? ____		

Note: Samples may be affected when not transported at the temperature recommended by the EPA for the test you've selected. Please contact the lab if you have concerns about the temperature of your samples.

COMMENTS: ____

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VIII.	Last page (Blank)	28

John B. Ashe, PhD
President

LAB NUMBER	SAMPLE I.D.	As (mg/kg)	As FLAG	Cd (mg/kg)	Cd FLAG	Cu (mg/kg)	Cu FLAG
7-2004	VSB-6; 0-6"	198		12.0		2620	
7-2005	VSB-6; 6-12"	61.9		5.4	U	538	
7-2006	VSB-6; 12-18"	87.2		5.4	U	716	
7-2007	VSB-6; 18-24"	177		7.0		1590	
7-2008	VSB-7; 0-6"	169		10.6		1440	
7-2009	VSB-8; 0-6"	176		9.3		1620	
7-2010	VSB-8; 6-12"	243		12.5		1930	
7-2011	VSB-9 0-6"	256		10.6		2010	
7-2012	VSB-9 6-12"	385		23.4		4530	
7-2013	VSB-10 0-6"	288		8.3		2800	
7-2014	VSB-10 6-12"	253		5.4	U	1970	
7-2015	VSB-10 12-18"	285		22.6		3100	
7-2016	VSB-10 18-24"	265		16.3		3100	
7-2017	VSB-5 0-6"	189		5.4	U	1010	
7-2018	VSB-5 6-12"	98.3		5.4	U	654	
7-2019	VSB-5 12-18"	64.8		8.2		662	
7-2020.1	VSB-4 0-6"	316		12.5		3920	
7-2021	VSB-4 6-12"	318		9.4		2350	
7-2022	VSB-3 0-6"	189		10.9		2030	
7-2023	VSB-3 6-12"	305		16.8		3190	
7-2024	VSB-2 0-6"	229		13.3		2510	
7-2025	VSB-2 6-12"	225		12.3		3280	
7-2026	VSB-0 0-6"	275		12.0		3020	
7-2027	VSB-0 6-12"	318		12.0		5260	
7-2028	VSB-1 0-6"	302		16.1		3320	
7-2029	VSB-1 6-12"	289		15.5		3870	
7-2030	VSB-12 6-12"	304		18.6		4110	
7-2031	VS-101 0-6"	67.5		5.4	U	93.2	
7-2032	VS-101 6-12"	35.6		5.4	U	206	
7-2033	VS-101 12-18"	118		5.4	U	384	
7-2034	VS-102 0-6"	155		5.4	U	281	
7-2035	VS-102 6-12"	43.6		5.4	U	196	
7-2036	VS-102 12-18"	42.8		5.4	U	547	
7-2037	VS-103 0-6"	128		5.4	U	423	
7-2038	VS-103 6-12"	15.6		5.4	U	302	
7-2039	VS-103 12-18"	10.9		5.4	U	398	
7-2040.1	VS-104 0-6"	390		5.4	U	1670	
7-2041	VS-104 6-12"	1050		24.1		4490	
7-2042	VS-104 12-18"	29.2		5.4	U	121	
7-2043	VS-105 0-6"	366		5.4	U	538	
7-2044	VS-105 6-12"	350		5.4	U	365	
7-2045	VS-105 12-18"	35.3		6.0		378	
7-2046	VS-106 0-6"	115		5.4	U	290	
7-2047	VS-107 0-12"	565		13.9		5530	
7-2048	VS-108 0-12"	275		5.4	U	792	
7-2049	VS-109 0-6"	145		5.4	U	428	
7-2050	VS-109 6-12"	45.2		5.4	U	111	

LAB NUMBER	SAMPLE I.D.	As (mg/kg)	As FLAG	Cd (mg/kg)	Cd FLAG	Cu (mg/kg)	Cu FLAG
7-2051	VS-109 12-18"	28.3		5.4	U	113	
7-2052	VS-110 6-12"	52.8		5.4	U	116	
7-2053	VS-111 0-6"	2240		6.5		5310	
7-2054	VS-111 6-12"	19.2		5.4	U	639	
7-2055	VS-111 12-18"	14.8		5.4	U	75.5	
7-2056	VS-112 0-6"	417		5.4	U	2270	
7-2057	VS-112 6-12"	134		5.4	U	606	
7-2058	VS-113 0-6"	113		5.4	U	621	
7-2059	VS-113 6-12"	75.0		5.4	U	277	
7-2060.1	VS-113 12-18"	29.9		5.4	U	55.3	
7-2061	VS-114 0-6"	47.4		5.4	U	83.6	
7-2062	VS-114 6-12"	29.3		5.4	U	54.5	
7-2063	VS-114 12-18"	22.5		5.4	U	58.7	
7-2064	VS-115 0-6"	330		5.4	U	1260	
7-2065	VS-115 6-12"	11.8		5.4	U	94.1	
7-2066	VS-115 12-18"	29.1		5.4	U	112	
7-2067	VS-116 0-6"	2120		53.9		47700	
7-2068	VS-116 6-12"	1480		23.2		7980	
7-2069	VS-116 12-18"	597		9.7		3800	
7-2070	VS-117 6-12"	1530		21.1		8630	
7-2071	VS-118 0-6"	1330		15.6		1680	
7-2072	VS-118 6-12"	433		5.6		1050	
7-2073	VS-118 12-18"	87.7		5.4	U	214	
7-2074	VS-119 6-12"	3030		23.9		14400	
7-2075	VS-120 0-6"	57.8		5.4	U	241	
7-2076	VS-120 6-12"	31.7		5.4	U	129	
7-2077	VS-120 12-18"	26.5		5.4	U	52.1	
7-2119	VSB-0 12-18"	381		6.9		4380	
7-2121.1	VSB-11 6-12"	309		10.4		2580	
7-2122	VSB-7 6-12"	201		13.1		2220	
7-2123	VS-112 12-18"	8.1	U	5.4	U	50.3	

LAB NUMBER	SAMPLE I.D.	Pb (mg/kg)	Pb FLAG	Zn (mg/kg)	Zn FLAG	SAMPLE PREP GROUP
7-2004	VSB-6; 0-6"	557		2720		999379
7-2005	VSB-6; 6-12"	138		752		999379
7-2006	VSB-6; 12-18"	193		1130		999379
7-2007	VSB-6; 18-24"	365		2750		999379
7-2008	VSB-7; 0-6"	495		2490		999379
7-2009	VSB-8; 0-6"	344		2140		999379
7-2010	VSB-8; 6-12"	648		3030		999379
7-2011	VSB-9 0-6"	626		2670		999379
7-2012	VSB-9 6-12"	823		5800		999379
7-2013	VSB-10 0-6"	784		2550		999379
7-2014	VSB-10 6-12"	622		2100		999379
7-2015	VSB-10 12-18"	861		4670		999379
7-2016	VSB-10 18-24"	760		3820		999379
7-2017	VSB-5 0-6"	482		1610		999379
7-2018	VSB-5 6-12"	136		1100		999379
7-2019	VSB-5 12-18"	107		1510		999379
7-2020.1	VSB-4 0-6"	1120		3570		999379
7-2021	VSB-4 6-12"	1080		2970		999380
7-2022	VSB-3 0-6"	586		2930		999380
7-2023	VSB-3 6-12"	923		4240		999380
7-2024	VSB-2 0-6"	900		3920		999380
7-2025	VSB-2 6-12"	724		3690		999380
7-2026	VSB-0 0-6"	1110		4270		999380
7-2027	VSB-0 6-12"	1160		4590		999380
7-2028	VSB-1 0-6"	942		4180		999380
7-2029	VSB-1 6-12"	1030		4690		999380
7-2030	VSB-12 6-12"	980		4650		999380
7-2031	VS-101 0-6"	91.0		346		999380
7-2032	VS-101 6-12"	181		405		999380
7-2033	VS-101 12-18"	917		1860		999380
7-2034	VS-102 0-6"	94.9		241		999380
7-2035	VS-102 6-12"	45.4		89.6		999380
7-2036	VS-102 12-18"	66.3		159		999380
7-2037	VS-103 0-6"	245		366		999380
7-2038	VS-103 6-12"	29.6		96.9		999380
7-2039	VS-103 12-18"	27.7		119		999380
7-2040.1	VS-104 0-6"	711		1770		999380
7-2041	VS-104 6-12"	10900		15200		999380
7-2042	VS-104 12-18"	88.0		879		999380
7-2043	VS-105 0-6"	995		1200		999380
7-2044	VS-105 6-12"	817		1090		999380
7-2045	VS-105 12-18"	175		1240		999380
7-2046	VS-106 0-6"	108		248		999380
7-2047	VS-107 0-12"	656		3290		999380
7-2048	VS-108 0-12"	322		2050		999380
7-2049	VS-109 0-6"	136		462		999380
7-2050	VS-109 6-12"	40.0		163		999380

LAB NUMBER	SAMPLE I.D.	Pb (mg/kg)	Pb FLAG	Zn (mg/kg)	Zn FLAG	SAMPLE PREP GROUP
7-2051	VS-109 12-18"	38.6		148		999380
7-2052	VS-110 6-12"	43.1		154		999380
7-2053	VS-111 0-6"	1120		2720		999380
7-2054	VS-111 6-12"	44.4		949		999380
7-2055	VS-111 12-18"	30.1		191		999380
7-2056	VS-112 0-6"	12000		14400		999380
7-2057	VS-112 6-12"	1470		2450		999380
7-2058	VS-113 0-6"	1020		1720		999380
7-2059	VS-113 6-12"	927		1240		999380
7-2060.1	VS-113 12-18"	31.9		236		999380
7-2061	VS-114 0-6"	223		208		999381
7-2062	VS-114 6-12"	95.2		110		999381
7-2063	VS-114 12-18"	30.7		61.0		999381
7-2064	VS-115 0-6"	503		484		999381
7-2065	VS-115 6-12"	232		125		999381
7-2066	VS-115 12-18"	134		143		999381
7-2067	VS-116 0-6"	1960		20800		999381
7-2068	VS-116 6-12"	1430		4810		999381
7-2069	VS-116 12-18"	770		3000		999381
7-2070	VS-117 6-12"	1690		5230		999381
7-2071	VS-118 0-6"	685		6480		999381
7-2072	VS-118 6-12"	467		1790		999381
7-2073	VS-118 12-18"	229		406		999381
7-2074	VS-119 6-12"	1590		8380		999381
7-2075	VS-120 0-6"	251		438		999381
7-2076	VS-120 6-12"	265		601		999381
7-2077	VS-120 12-18"	14.3		113		999381
7-2119	VSB-0 12-18"	1200		3870		999381
7-2121.1	VSB-11 6-12"	1010		2890		999381
7-2122	VSB-7 6-12"	590		3810		999381
7-2123	VS-112 12-18"	52.6		461		999381

QA/QC SAMPLES

SAMPLE LABEL	PB PPM	CU PPM	ZN PPM	AS PPM	CD PPM
N-2710/A ICV, 9/17/97	5540.169	2872.71	6828.039	602.459	20.202
CERTIFIED	5532	2950	6952	626	21.8
RECOVERY	100.15	97.38	98.22	96.24	92.67
999379	1.064	0.333	2.88		0.265
990379	1.95	3.885			
ABOVE BLANKS ASSOCIATED WITH SAMPLE PREP GROUP 999379.					
N-2710/A LCS	5583.606	2961.174	6926.72	583.743	18.497
CERTIFIED	5532	2950	6952	626	21.8
RECOVERY	100.93	100.38	99.64	93.25	84.85
ABOVE LCS ASSOCIATED WITH SAMPLES 7-2004 THRU 7-2018.					
7-2020.1	1117.805	3919.562	3574.486	316.233	12.544
7-2020.2 LAB DUP	1149.345	4025.58	3603.521	307.221	13.541
7-2020R LAB REP	1117.879	4469.956	3910.189	315.081	16.408
LAB DUP RPD	2.78	2.67	0.81	2.89	7.64
LAB REP RPD	0.01	13.12	8.97	0.36	26.69
N-2710/A LCS	5589.832	2941.946	7005.644	544.267	19.14
CERTIFIED	5532	2950	6952	626	21.8
RECOVERY	101.05	99.73	100.77	86.94	87.80
ABOVE LCS ASSOCIATED WITH SAMPLES 7-2019 THRU 7-2030.					
7-2040.1	711.157	1674.68	1765.592	389.786	2.366
7-2040.2	711.792	1677.092	1744.395	387.252	3.184
7-2040R	714.997	1679.634	1756.4	381.729	1.731
LAB DUP RPD	0.09	0.14	1.21	0.65	29.48
LAB REP RPD	0.54	0.30	0.52	2.09	31.00
999380	3.671	2.807	1.127		
990380	1.421	1.942		0.537	0.496
ABOVE BLANKS ASSOCIATED WITH SAMPLE PREP GROUP 999380.					
N-2710/A LCS	5505.115	2902.902	6950.467	625.133	21.031
CERTIFIED	5532	2950	6952	626	21.8
RECOVERY	99.51	98.40	99.98	99.86	96.47
ABOVE LCS ASSOCIATED WITH SAMPLES 7-2031 THRU 7-2040.					
N-2710/A ICV, 9/18/97	5538.147	2953.286	6910.278	631.313	21.45
CERTIFIED	5532	2950	6952	626	21.8
RECOVERY	100.11	100.11	99.40	100.85	98.39

SAMPLE LABEL	PB PPM	CU PPM	ZN PPM	AS PPM	CD PPM
N-2710/A LCS	5532.16	2893.384	6897.94	645.623	19.366
CERTIFIED	5532	2950	6952	626	21.8
RECOVERY	100.00	98.08	99.22	103.13	88.83
ABOVE LCS ASSOCIATED WITH SAMPLES 7-2041 THRU 7-2055.					
7-2060.1	31.881	55.267	235.593	29.946	0.535
7-2060.2 LAB DUP	37.768	55.102	231.35	27.983	2.135
7-2060R LAB REP	37.844	52.783	225.836	25.805	0.227
LAB DUP RPD	16.90	0.30	1.82	6.78	119.85
LAB REP RPD	17.10	4.60	4.23	14.86	80.84
N-2710/A LCS	5363.839	2899.089	6924.103	655.431	16.878
CERTIFIED	5532	2950	6952	626	21.8
RECOVERY	96.96	98.27	99.60	104.70	77.42
ABOVE LCS ASSOCIATED WITH SAMPLES 7-2056 THRU 7-2071.					
7-2121.1	1010.024	2583.893	2888.056	309.454	10.413
7-2121.2 LAB DUP	1044.006	2599.573	2942.201	301.623	7.727
7-2121R LAB REP	1031.373	2542.044	2909.922	295.167	7.906
LAB DUP RPD	3.31	0.61	1.86	2.56	29.61
LAB REP RPD	2.09	1.63	0.75	4.73	27.37
999381	5.641	5.581	0.704		
990381	3.336	8.792		2.352	
ABOVE BLANKS ASSOCIATED WITH SAMPLE PREP GROUP 999381					
N-2710/A LCS	5628.606	2949.76	6985.301	574.389	18.43
CERTIFIED	5532	2950	6952	626	21.8
RECOVERY	101.75	99.99	100.48	91.76	84.54
ABOVE LCS ASSOCIATED WITH SAMPLES 7-2072 THRU 7-2123.					

3rd Q 1997
DETECTION LIMITS

ANALYTE	MDL (mg/kg)	LOQ (mg/kg)
As	8.1	27.0
Cd	5.4	18.0
Cu	14.1	47.0
Hg	5.0	16.7
Pb	6.2	20.7
Zn	11.8	39.3

RAW DATA

SAMPLE LABEL	PB PPM	CU PPM	ZN PPM	AS PPM	CD PPM
N-2710/A	5540.169	2872.71	6828.039	602.459	20.202
999379	1.064	0.333	2.88		0.265
990379	1.95	3.885			
7-2004	556.627	2619.401	2715.725	197.547	11.951
7-2005	137.96	538.101	751.796	61.933	3.501
7-2006	193.222	715.662	1127.81	87.16	3.887
7-2007	364.968	1593.313	2746.753	177.028	6.986
7-2008	495.076	1444.189	2492.141	169.296	10.616
7-2009	343.783	1622.351	2140.2	175.935	9.271
7-2010	648.347	1932.595	3025.486	243.226	12.494
7-2011	625.797	2011.507	2671.426	255.635	10.634
7-2012	823.341	4530.365	5797.076	385.121	23.392
7-2013	784.439	2801.876	2551.36	287.741	8.289
7-2014	622.485	1969.077	2099.176	253.319	5.152
7-2015	860.552	3100.24	4665.561	285.448	22.613
7-2016	759.69	3102.591	3818.204	265.318	16.275
7-2017	481.585	1006.595	1609.025	188.968	4.206
7-2018	136.065	654.224	1102.222	98.252	2.689
N-2710/A	5583.606	2961.174	6926.72	583.743	18.497
7-2019	106.787	662.202	1512.576	64.763	8.242
7-2020.1	1117.805	3919.562	3574.486	316.233	12.544
7-2020.2	1149.345	4025.58	3603.521	307.221	13.541
7-2020R	1117.879	4469.956	3910.189	315.081	16.408
7-2021	1077.608	2354.322	2967.024	318.003	9.35
7-2022	585.628	2033.13	2926.102	189.097	10.918
7-2023	923.467	3185.13	4238.239	305.223	16.772
7-2024	899.764	2510.097	3916.8	228.941	13.281
7-2025	724.314	3281.522	3687.55	225.161	12.348
7-2026	1114.854	3024.084	4273.175	274.839	11.97
7-2027	1158.711	5257.014	4588.713	318.001	12.018
7-2028	942.275	3315.424	4181.45	301.686	16.1
7-2029	1030.329	3866.815	4689.059	289.187	15.479
7-2030	979.827	4107.623	4647.048	303.721	18.613
N-2710/A	5589.832	2941.946	7005.644	544.267	19.14
7-2031	91.005	93.182	346.033	67.547	0.956
7-2032	181.487	206.184	404.635	35.631	0.652
7-2033	916.592	384.197	1856.679	118.239	4.644
7-2034	94.88	280.786	240.531	155.08	
7-2035	45.417	195.869	89.586	43.637	
7-2036	66.327	547.248	159.301	42.812	3.004
7-2037	244.995	422.758	366.275	127.862	2.092
7-2038	29.561	301.525	96.946	15.568	2.217
7-2039	27.662	397.888	118.748	10.876	0.513
7-2040.1	711.157	1674.68	1765.592	389.786	2.366
7-2040.2	711.792	1677.092	1744.395	387.252	3.184
7-2040R	714.997	1679.634	1756.4	381.729	1.731
999380	3.671	2.807	1.127		
990380	1.421	1.942		0.537	0.496
N-2710/A	5505.115	2902.902	6950.467	625.133	21.031

SAMPLE LABEL	PB PPM	CU PPM	ZN PPM	AS PPM	CD PPM
N-2710/A	5538.147	2953.286	6910.278	631.313	21.45
7-2041	10889.427	4485.831	15200.638	1049.597	24.081
7-2042	87.951	120.59	878.678	29.155	4.486
7-2043	994.946	538.413	1199.342	365.68	2.857
7-2044	816.515	365.041	1087.718	350.354	3.702
7-2045	174.781	377.5	1243.307	35.273	6.049
7-2046	107.62	290.027	248.043	114.664	1.734
7-2047	656.345	5534.857	3287.567	565.126	13.902
7-2048	321.806	792.449	2050.115	274.909	4.264
7-2049	136.387	428.357	462.092	144.707	0.306
7-2050	39.995	111.255	162.548	45.225	0.316
7-2051	38.646	112.998	147.658	28.332	
7-2052	43.13	115.709	154.365	52.809	0.023
7-2053	1119.808	5312.189	2715.527	2238.923	6.49
7-2054	44.438	639.123	948.524	19.164	5.268
7-2055	30.093	75.533	190.821	14.793	1.166
N-2710/A	5532.16	2893.384	6897.94	645.623	19.366
7-2056	12027.649	2266.784	14417.912	417.001	4.773
7-2057	1470.786	605.576	2445.598	133.827	2.712
7-2058	1020.595	621.468	1717.012	112.84	1.628
7-2059	927.024	276.597	1237.252	75.038	1.916
7-2060.1	31.881	55.267	235.593	29.946	0.535
7-2060.2	37.768	55.102	231.35	27.983	2.135
7-2060R	37.844	52.783	225.836	25.805	0.227
7-2061	222.68	83.633	207.936	47.389	2.015
7-2062	95.186	54.525	110.368	29.326	1.792
7-2063	30.725	58.658	61.034	22.535	0.326
7-2064	502.945	1263.338	484.139	330.432	2.124
7-2065	232.197	94.078	125.106	11.779	0.774
7-2066	134.103	111.725	143.088	29.113	0.232
7-2067	1955.105	47684.617	20776.086	2121.692	53.903
7-2068	1428.703	7983.968	4811.256	1478.365	23.207
7-2069	769.659	3804.044	3000.285	596.682	9.712
7-2070	1687.161	8630.262	5234.462	1532.239	21.096
7-2071	685.424	1681.483	6477.216	1329.081	15.595
N-2710/A	5363.839	2899.089	6924.103	655.431	16.878
7-2072	466.957	1049.839	1787.839	433.385	5.641
7-2073	228.571	214.065	405.751	87.734	0.614
7-2074	1590.403	14445.149	8384.419	3027.236	23.881
7-2075	251.229	241.2	438.289	57.779	0.295
7-2076	264.627	128.646	600.958	31.699	1.323
7-2077	14.349	52.091	112.939	26.512	0.227
7-2119	1197.973	4375.664	3868.131	380.701	6.891
7-2121.1	1010.024	2583.893	2888.056	309.454	10.413
7-2121.2	1044.006	2599.573	2942.201	301.623	7.727
7-2121R	1031.373	2542.044	2909.922	295.167	7.906
999381	5.641	5.581	0.704		
990381	3.336	8.792		2.352	
7-2122	589.795	2221.066	3806.139	201.166	13.066
7-2123	52.639	50.321	461.491		1.91
N-2710/A	5628.606	2949.76	6985.301	574.389	18.43

Lab Number	Sample I.D.	Sample Date	Date Rec'd
7-1990	D4-55-RS-038		9/11/97
7-1991	-039		
7-1992	-040		
7-1993	-041		
7-1994	-042		
7-1995	-043		
7-1996	-044		
7-1997	D4-55-RS-045		9/11/97
7-1998	FSP46		9/11/97
7-1999	FSP47		9/11/97
7-2000	Mill Creek East Triangle		9/11/97
7-2001	ML MMT-142	(139)	9/11/97
7-2002	ML MMT-143	(208)	
7-2003	ML MMT-144	(354)	9/11/97
7-2004	VSB-6 ; 0"-6"		9/12/97
7-2005	VSB-6 ; 6"-12"		
7-2006	VSB-6 ; 12-18"		
7-2007	VSB-6 ; 18"-24"		
7-2008	VSB-7 ; 0"-6"		
7-2009	VSB-8 ; 0"-6"		
7-2010	VSB-8 ; 6"-12"		9/12/97

Survey Ca, P, As

Wash water Ca, P, As

Caustic Wash Ca, P, As

Lab Number	Sample I.D.		Sample Rec'd	Data Rec'd
Z-2011	VSB-9	0"-6"		9/12/97
Z-2012	VSB-9	6"-12"		
Z-2013	VSB-10	0"-6"		
Z-2014	VSB-10	6"-12"		
Z-2015	VSB-10	12"-18"		
Z-2016	VSB-10	18"-24"		
Z-2017	VSB-5	0"-6"		
Z-2018	VSB-5	6"-12"		
Z-2019	VSB-5	12"-18"		
Z-2020	VSB-4	0"-6"		
Z-2021	VSB-4	6"-12"		
Z-2022	VSB-3	0"-6"		
Z-2023	VSB-3	6"-12"		
Z2024	VSB-2	0"-6"		
Z-2025	VSB-2	6"-12"		
Z-2026	VSB-0	0-6"		
Z-2027	VSB-0	6"-12"		
Z2028	VSB-1	0"-6"		
Z2029	VSB-1	6"-12"		
Z2030	VSB-12	6"-12"		
Z-2031	VS-101	0"-6"	9/12/97	

Lab Number	Sample I.D.		Sample Dat	Data Rcvd
7-2032	VS-101	6"-12"		9/12/97
7-2033	VS-101	12"-18"		
7-2034	VS-102	0"-6"		
7-2035	VS-102	6"-12"		
7-2036	VS-102	12"-18"		
7-2037	VS-103	0"-6"		
7-2038	VS-103	6"-12"		
7-2039	VS-103	12"-18"		
7-2040	VS-104	0"-6"		
7-2041	VS-104	6"-12"		
7-2042	VS-104	12-18"		
7-2043	VS-105	0-6"		
7-2044	VS-105	6-12"		
7-2045	VS-105	12-18"		
7-2046	VS-106	0"-6"		
7-2047	VS-107	0-12"		
7-2048	VS-108	0-12"		
7-2049	VS-109	0-6"		
7-2050	VS-109	6-12"		
7-2051	VS-109	12-18"		
7-2052	VS-110	6-12"		9/12/97

Number	Sample I.D.	Sample Date	Date Received
7-2053	VS-111	0-6"	9/12/97
7-2054	VS-111	6-12"	
7-2055	VS-111	12-18"	
7-2056	VS-112	0-6"	
7-2057	VS-112	6-12"	
7-2058	VS-113	0-6"	
7-2059	VS-113	6"-12"	
7-2060	VS-113	12-18"	
7-2061	VS-114	0-6"	
7-2062	VS-114	6-12"	
7-2063	VS-114	12-18"	
2064	VS-115	0-6"	
7-2065	VS-115	6-12"	
7-2066	VS-115	12-18"	
7-2067	VS-116	0-6"	
7-2068	VS-116	6-12"	
7-2069	VS-116	12-18"	
7-2070	VS-117	6"-12"	
7-2071	VS-118	0-6"	
7-2072	VS-118	6-12"	
7-2073	VS-118	12-18"	9/12/97

Lab Number	Sample ID	Sample Date	Date Rec'd
7-2074	VS-119 6-12"		9/12/97
7-2075	VS-120 0-6"		"
7-2076	VS-120 6-12"		"
7-2077	VS-120 12-18"		9/12/97
7-2078	DL-55-RS-010		9/12/97
7-2079	-046		"
7-2080	-047		"
7-2081	-048		"
7-2082	-049		"
7-2083	-050		"
7-2084	-051		"
7-2085	-052		"
7-2086	-053		"
7-2087	-054		"
7-2088	-055		"
7-2089	-056		"
7-2090	-058		"
-2091	-059		"
2092	-060		"
2093	-061		"
-2094	DL-55-RS-062		9/12/97

Number	Sample ID	Sample Date	Data Rcvd	
2116	DL-SS-R6-007		9/12/97	
2117	FSP48		9/12/97	
2118	FSP49		9/13/97	
2119	VSB-0 12-18"		9/12/97	
2120	FSP50		9/15/97	
2121	VSB-11, 6"-12"		9/16/97	
2122	VSB-7 6-12"		↕	
2123	VS-112 12-18"		9/12/97	
2124	MTCON Ditch 9/16/97		9/16/97	
2	MG-CB8-91597-1135-Comp-003		9/16/97	
26	MG-CB8-91597-1135-Comp-003/D		↑	
27	MG-CB8-91597-1040-Comp-001			
28	MG-CB8-91597-1050-Comp-002			
29	MG-CB8-91597-1145-Comp-004			
30	MG-CB8-91597-1210-Comp-005			
31	MG-CB8-91597-1215-Comp-006		9/16/97	
32	HT Fe As 30		9/16/92	
3	HT Fe P 30		↕	
4	HT Fe As P30		9/16/97	
5	FSP51		9/16/97	
6	FSP52		9/17/97	

9/17/97

Scale Weight	Calibration Reading
5g	5.0g
10g	10.0g
20g	20.0g
50g	50.0g

Lot # 7 Cleaning Sand

Sample I.D.	Grinding Vessel	Sample wt (gm)
7-2004	1	14.8
7-2005	2	14.6
7-2006	3	14.8
7-2007	1	14.8
7-2008	2	14.7
7-2009	3	14.7
7-2010	1	14.8
7-2011	2	14.6
7-2012	3	14.8
7-2013	1	14.7
7-2014	2	14.9
7-2015	3	14.9
7-2016	1	14.9
7-2017	2	14.7
7-2018	3	14.4
7 2019	1	14.7
7 2020	2	16.0

wt (gm)
16
14.8
14.9
14.6
15.2
14.7

John Allen
9/17/97

9/17/97 (Cont.)

9/17/9

000018

Lot # 7 Cleaning Sand

Sample ID	Grader Vessel	Sample Wt (gms)	Sa
7-2020L	3	16.0	
7-2021	1	14.9	
7-2022	2	14.6	
7-2023	3	14.2	
7-2024	1	14.8	
7-2025	2	14.8	
7-2026	3	14.7	
7-2027	1	14.9	
7-2028	2	14.9	
7-2029	3	14.7	
7-2030	1	14.5	
7-2031	2	14.9	
7-2032	3	14.7	
7-2033	1	14.1	
7-2034	2	14.9	
7-2035	3	14.4	
7-2036	1	14.3	
7-2037	2	14.7	
7-2038	3	14.6	
7-2039	1	14.7	

9/17/97 DSD

John Klerk
9/17/97

2/17/97 (cont)

Lot #7 Cleaning Lead

Sample I.D.		Granule Vessel	Sample wt (gms)
7-2040		2	17.6
7-2040R		3	17.6
7-2041	999380, 990880	1	13.3, 13.1
7-2042	7-2041	2	14.9
7-2043	7-2042	3	14.7
7-2044	7-2043	1	14.7
7-2045	7-2044	2	14.6
7-2046	7-2045	3	14.6
7-2047	7-2046	1	14.8
7-2048	7-2047	2	14.3
7-2049	7-2048	3	14.7
72049		1	14.4
7-2050		2	14.9
7-2051		3	14.7
7-2052		1	148
7-2053		2	14.6
7-2054		3	14.8
7-2055		1	147
7-2056		2	14.9
7-2057		3	14.9

2/17/97

9/17/97

Lot # 7 Clearing Sand

000020

Sample ID	Grinding Vessel	Sample Wt (gms)
7-2058	1	14.4
7-2059	2	14.9
7-2060	3	14.4
7-2060R	1	14.7
7-2061	2	14.6
7-2062	3	14.6
7-2063	1	14.9
7-2064	2	14.9
7-2065	3	14.8
7-2066	1	14.7
7-2067	2	14.7
7-2068	3	14.8
7-2069	1	14.7
7-2070	2	14.4
7-2071	3	14.7
7-2072	1	14.9
7-2073	2	13.4
7-2074	3	14.7
7-2075	1	14.8
7-2076	2	14.9
7-2077	3	13.6

9/17/97

9/17/97 (cont)

Lot # 7 Cleaning Sand

Sample I.D.	Grinding Head	Sample wt. (gm)
7-2136	1	15.1
7-2137	1	14.6
7-2119	1	14.9
7-2121	2	17.6
7-2121R	3	17.7
~~7-2122~~ 999381, 990381	1	13.3, 13.2
7-2122	2	14.9
7-2123	3	14.8

John Black
9/17/97

APPENDIX E

TRANSPORTATION PLAN AND HAUL ROAD DATA

Preliminary Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

APPENDIX E-1

Transportation Plan

DRAFT TRANSPORTATION PLAN

INTRODUCTION

This Transportation Plan (TP) addresses the transportation of materials within and outside the boundaries for Remedial Action in Subarea 1 of the Streamside Tailings Operable Unit (SST OU) along Silver Bow Creek in southwestern Montana. This TP states the methods for transporting tailings/impacted soils material from the floodplain to designated Mine Waste Relocation Repositories (MWRRs) as well as transporting clean borrow material to backfill the remediated floodplain.

One of the primary concerns of transporting large amounts of tailings/impacted soils and borrow material is safety. This document outlines several minimum safety requirements of the Contractor and on-site personnel. Included in the safety section of the document are items such as traffic controls, crossings, signing, speed limits, driver training, engineering controls, and access control.

This TP is intended to provide information on primary haul road locations, haul road construction, stream crossing construction, railroad crossing construction, and public road crossing construction. Specific methods and procedures used must be determined by the Contractor. This document is to serve primarily as a general guide to the Contractor. The Contractor will be required to submit a Traffic Control Plan (TCP) covering all proposed haul routes, traffic control, speed, signage, equipment specifications, driver qualifications, and traffic safety.

REGULATORY COMPLIANCE AND SAFETY

During tailings/impacted soils removal and stream and floodplain reconstruction operations in Subarea 1 of the SST OU, the safety of both on-site construction personnel and the public is the primary concern. Several precautions regarding the transportation of these materials will be required to insure the safety of all parties.

This TP has been prepared to meet Montana Department of Transportation (MDOT) and EPA regulations governing the on-site (non-public road use) and off-site (public road use) of hazardous and non-hazardous materials. Borrow source material, lime kiln dust, and mine waste are not considered hazardous material according to DOT regulations.

DOT and EPA regulations have been created to control and regulate the transportation of hazardous wastes. These regulations are listed in the Code of Federal Regulations (CFR) including 40 CFR 262 and 263, 49 CFR 172 and 173, and 49 CFR 390-397. The federal regulations governing the on-site and off-site transport of hazardous and non-hazardous materials are presented in the following sections. These regulations have been adopted by the State of Montana Motor Carrier Safety Assistance Program (MCSAP).

On-site Transportation Activities

On-site transportation activities consist of those that do not require the use of public roads. These activities will include the hauling of tailings/impacted soils to on-site MWRRs and hauling of clean replacement borrow materials. The majority of the transportation activities will be limited to on-site traffic.

Federal regulations do not regulate on-site transportation of hazardous wastes. However, all personnel working in areas of remediation where significant exposure could occur are required to have 40 hours of training which complies with the Occupational Safety and Health Administration (OSHA) regulations (29 CFR 1910.120).

Off-site Transportation Activities

Off-site transportation activities consist of operations that require the use of public roads. Non-hazardous materials which will be transported on public roads include tailings/impacted soils, borrow material, lime amendment material, and fill for haul road construction.

There are several regulations governing the off-site transportation of hazardous waste. Ore concentrate spills along the railroads may be classified as a hazardous waste. If required, the following regulations summarize the applicable requirements for off-site transportation of hazardous materials:

- 49 CFR 172.101, Waste Classification - Assigned the appropriate DOT hazard class and identifications number.
- 49 CFR 173.1300, Packaging Requirements - "Vehicle must be free from leaks and all discharge openings must be securely closed during transportation"
- 49 CFR 172.500, Placarding - All vehicles transporting hazardous material must display the appropriate placards.
- 40 CFR 263.111, EPA Identifications Number - Each transporter of hazardous materials must obtain a EPA designated identification number.
- 40 CFR 263.20-263.22, Manifest Requirements - A manifest must be properly filled out and signed by both the generator and transporter.
- 49 CFR 172.602, Emergency Response Information - An emergency response plan is required for some type of hazardous wastes.
- 49 CFR 172.604, Emergency Response Telephone Number - An emergency response number must be established and monitored by the contractor at all times of transport. The designated monitor must have knowledge of the characteristics of the hazardous material being transported. The telephone number must be displayed on each transport manifest.
- 40 CFR 263.30, Hazardous Waste Discharges - In the event of a hazardous waste discharge, the transporter must take appropriate, immediate action to protect human health and the environment.
- 49 CFR 177.816, Driver Training Requirements - Each carrier will provide training to drivers as required by this regulation and the Federal Motor Carrier Safety Regulations Parts 390-397.

Driver Qualifications

The Contractor will verify that all drivers comply with appropriate federal, state and local regulations as they apply to the transport of hazardous materials (40 CFR 177.816). All personnel working in areas of remediation where significant exposure could occur are required to have 40 hours of training which complies with the Occupational Safety and Health Administration (OSHA) regulations (29 CFR 1910.120). In addition, all drivers must show documentation of driver training by a independent training agency.

The Contractor will keep complete records of all driver training and activities associated with transporting the materials. These records will include statements of driver qualifications, accident reports, notes, memos, and other forms of written communication collected during site activities.

Site Access Control

Areas of controlled access will be fenced with specific access locations. The access locations will be gated and locked during non-working hours. The Contractor will be responsible for security of staging areas and equipment storage sites. No personnel will be granted access to construction areas without documentation of proper training (OSHA 40-hour), proper safety equipment, and authorization to enter the exclusion zone.

Sight Distance

The sight distance is defined as "the extent of peripheral area visible to the vehicle operator." The sight distance must be greater than the stopping distance for a vehicle traveling at a given speed. On vertical

crests, the sight distance is limited by the road surface. On horizontal curves the sight distance is limited by adjacent berm dikes, steep road cuts, trees, and structures.

All haul roads must be designed and routed to enable the maximum sight distance. If it is not possible to eliminate short sight distance areas, maximum speeds must be established to reduce the stopping distance to less than the sight distance.

Traffic Flow and Traffic Control

Haul routes and traffic controls will be appropriate to the type and size of equipment used. It is anticipated that large off-road trucks, scrapers, and excavation equipment will be used during construction activities. Right-of ways will be established and signs and/or flaggers will be used to maintain traffic flow at intersections or appropriate locations along public roads. The Contractor will be required to submit a TCP in accordance with the Manual of Uniform Traffic Control Devices for Streets and Highways (MUTCD) outlining traffic controls, signing, barricades, and access control stations.

Traffic control will consist of posting appropriate stop signs, speed limit signs, and warning signs. The on-site traffic control will be established to maintain the flow of traffic for large off-road construction equipment. Secondary vehicle traffic will be required to keep night running lights on at all times while on-site. The Contractor's Final TCP will identify, describe and show a graphical plan for traffic controls to be using including signage, coning, flaggers, and barricades, as appropriate.

Traffic control will also include control of crossings of Rarus Railway. There are two haul road crossings of Rarus Railway in this project. Rarus Railway will require either automatic signals at these crossings or one flagger at each crossing. The Contractor shall coordinate the required crossing system with Rarus Railway. Flaggers will only be required at railway crossings on days that trains are running. Presently, trains run two days a week but the schedule is subject to change.

ENGINEERING CONTROLS

Engineering controls will be implemented to minimize human health and environmental impacts associated with dust generation, noise due to equipment, and regulation of haul hours.

Dust

All roads, MWRRs, and borrow areas will be watered on a regular schedule to minimize the generation of airborne dust by equipment or wind. It is expected that at least one water truck will be required to continuously water these areas to minimize dust. During the summer when precipitation is low and heat is high it is expected that at least two water trucks will be required.

Noise

Workers on-site in areas of noisy equipment will be required to wear hearing protection equipment. Hearing protection equipment must be made available to all on-site personnel by their respective supervisor.

Haul Hours

Hauling of materials will be limited to daylight hours. The Contractor may conduct work 7 days a week for the duration of the project.

VEHICLE SPECIFICATIONS

The Contractor will identify haul vehicles proposed to transport excavated tailings/impacted soils, borrow material, and lime. The gross and tare weight of the vehicles must be submitted along with the volume

capacity and vehicle width. The haul vehicles designated to be used on public roadways will comply with the requirement of the MCSAP. All vehicles used will be designed and appropriate for the use.

Vehicle Staging Areas

Prior to the beginning of on-site activities a construction equipment staging area will be constructed. The area will contain all necessary equipment to maintain the on-site equipment including job trailer(s), maintenance areas, tools, and knowledgeable maintenance personnel. Staging areas are designated on the plan sheets. Areas will be cleared and grubbed and topsoil will be stripped and stockpiled before use. Topsoil will be replaced and revegetated in accordance with the revegetation specifications.

Vehicle Decontamination

Decontamination for vehicles excavating and transporting tailings/impacted soils, contaminated railroad material, or instream sediments will be required. Decontamination facilities will be established at the site boundary. Vehicles will be visually inspected and decontaminated, if necessary. The wash water and sediment generated will be collected and stored within the exclusion zone. Decontamination would occur only for equipment leaving the site. Haul roads used for hazardous material transport will be inspected and contaminated material removed and taken to the MWRRs after hauling has ceased. The decontamination water will be utilized for use as dust suppression or as water to aid with compaction in MWRRs.

Manifesting & Placards

Any vehicles which transport hazardous materials off-site on public roads will be required to keep a manifest. The manifest will include weight and volume of material in each vehicle. The Contractor will be required to ensure each form is complete including appropriate generator/transporter/destination, EPA identification numbers, DOT description, quantity , special handling instructions, and required signatures.

The Contractor will place hazardous material identification numbers on a placards in accordance with 49 CFR 172.336, on the sides and rear of each loaded truck which travels off-site. The Contractor will be responsible for placing the placards as well as identification numbering.

Maintenance & Repair

All haul vehicles will be maintained and repaired in accordance with the manufacture's recommendations. Any vehicles deemed unsafe by the Owner's Representative will be removed from service for repairs. Upon the completion of repairs, the vehicle must be reinspected and approved to continue service.

HAUL ROADS

For construction haul routes within or near Reach A and Subarea 1, there are two major design components: (1) haul road design, and (2) stream, diversion channel, and utility crossings.

Haul Road Design

The approximate alignment of the primary haul road, which is close to 16,000' long, is shown on Sheet 11a. The Contractor will have the responsibility to field locate the primary haul roads. Any deviation from the locations indicated on Sheet M11a, will require approval by the Owner's Representative. The locations of the secondary haul roads are not shown and will be determined by the Contractor with approval by the Owner's Representative.

Design and construction of both primary and secondary haul roads will be the responsibility of the Contractor. The haul roads shall be designed and constructed for the anticipated loads and sizes of trucks for hauling wastes and borrow materials. The Contractor shall provide adequate drainage

measures, including culverts at drainage crossings and road ditches. The will also be responsible for providing all maintenance and dust control for the haul roads. When running parallel to railroad lines, the edge of the road running surface whall be at least 20 feet from the centerline of the tracks. Included in this work will be the design and construction of approaches for public road crossings and railroad crossings. Public road and railroad crossings will be constructed to maximize vehicle visibility and stopping distance.

Haul roads constructed in Reach A and accessing MWRR 2 will be reclaimed after completion of the work for Reach A. Haul roads shall be regraded to the original ground topography and the stockpiled topsoil from the haul road areas shall be replaced. Revegetation of the haul road is to be in accordance with the revegetation plan described in section 3.12.

Stream, Diversion Channel, and Utility Crossings

Several utility, stream, and diversion channel crossings are required as part of the haul roads. Sheet M11a shows the locations of the stream and utility crossings for the primary haul road. The locations of the diversion channel will be determined by the Contractor and approved by the Owner's Representative. Utility crossings will be constructed in accordance with the appropriate utility requirements.

The primary haul road crosses the creek in two locations downstream of Reach A. Prior to construction of these sections of haul road in areas of tailings/impacted soils, an area sufficient to construct the road cross-section shall be cleared and grubbed. The tailings shall be excavated to the base of tailings as defined on Sheet M5???? These crossings shall be designed and constructed by the Contractor with approval from the Owner's Representative. The crossings shall be desinged to remain in place for at least 3 years. The crossings shall be culvert or other flow conveyance designed to pass approximately 229 cfs which is the approximate 2 year flow of Silver Bow Creek. The flows exceeding the 2 year event can overtop the the existing streambanks, similar to natural free-flow conditions. The road approaches to the crossings shall be at or below the floodplain surface grades to allow passage of flood flows with minmal backwater. The road fill over the flow structures shall be adequate to provide minimum cover requirements over the flow structures and maintain maximum road grades, but shall be designed as small as possible to create minimal flow obstruction to flood flows. The crossing shall include erosion protection for the flow structures and fill embankments.

Construction of diversion ditch crossings to access the floodplain from the primary haul road shall be accomplished in accordance with the design on Sheet I21. The number of diversion ditch crossings is at the discretion of the Contractor. The diversion ditch crossings may only be in place during the time of construction activities. If winter shut down is necessary, the crossings shall be entirely removed prior to the Contractor leaving the site. Once construction commences, diversion ditch crossings may be reconstructed. The diversion ditch shall be permanently removed at the end of the construction contract.

The utility crossings for the haul roads consist of measures to prevent damage to existing buried utilities. There are five types of buried utilities crossed by the planned haul roads: (1) the existing Silver Lake water line, (2) the existing water line for the Town of Rocker, (3) a natural gas line, (4) a fiber optic line, and (5) the Butte sewage sluge line. The utility crossings are identified on Sheet M11a. The Contractor shall design and install adequate structural measures to prevent damage to the utilities. The crossings must be designed to remain in place for three years. The designs and installation procedures shall be submitted to the appropriate Utility and the Owner's Representative for approval at least 14 days prior to installation, and it will be the Contractor's responsibility to coordinate with the appropriate utility representatives to determine locations and crossing requirements. It is anticipated that the Contractor will be required to locate the utilities at the exact crossing locations, determine their depths below the ground surface, obtain soil engineering properties of the overburden material, and conduct an engineering analysis to design an appropriate crossing structure.

APPENDIX E-2

Haul Road Data

MAXIM Technologies Inc

Consulting Engineers & Scientists

CALIFORNIA BEARING RATIO DATA SHEET

Project: Stream Side Tailings
Source: HR-CBR-01
Depth: 2.5' - 3.5'
Location: 900' NE of Pilot Test
Identification:

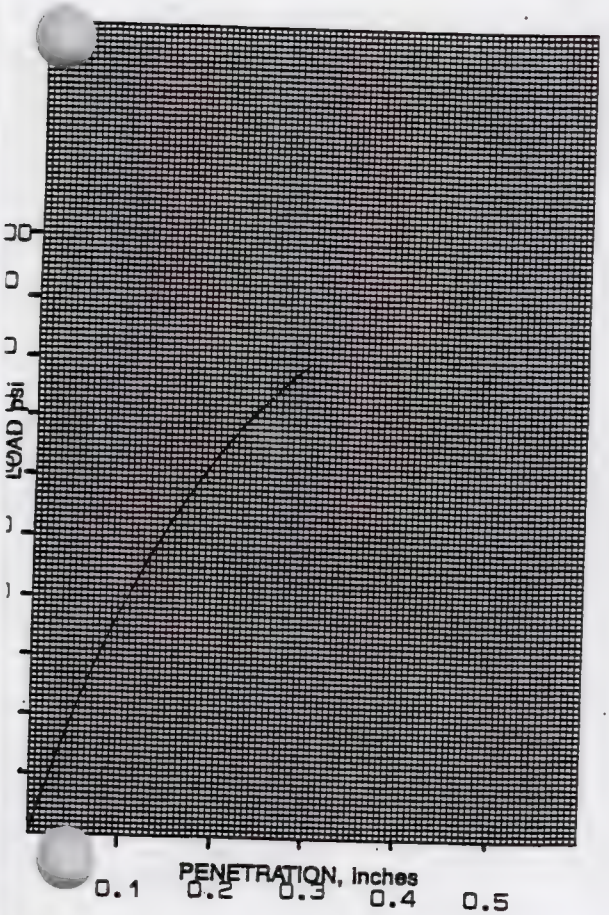
Sample No. 2451
Job No. 9731701.190
Sampled by Maxim
Date Sampled 1/28/98
Date Received 1/29/98

MECHANICAL ANALYSIS, % Pass

3" Sq.	
2" Sq.	100
1" Sq.	99
¾" Sq.	98
½" Sq.	97
3/8" Sq.	96
No. 4	89
No. 10	75
No. 20	48
No. 40	23
No. 80	5
No. 100	
No. 200	1.9
0.005 mm	

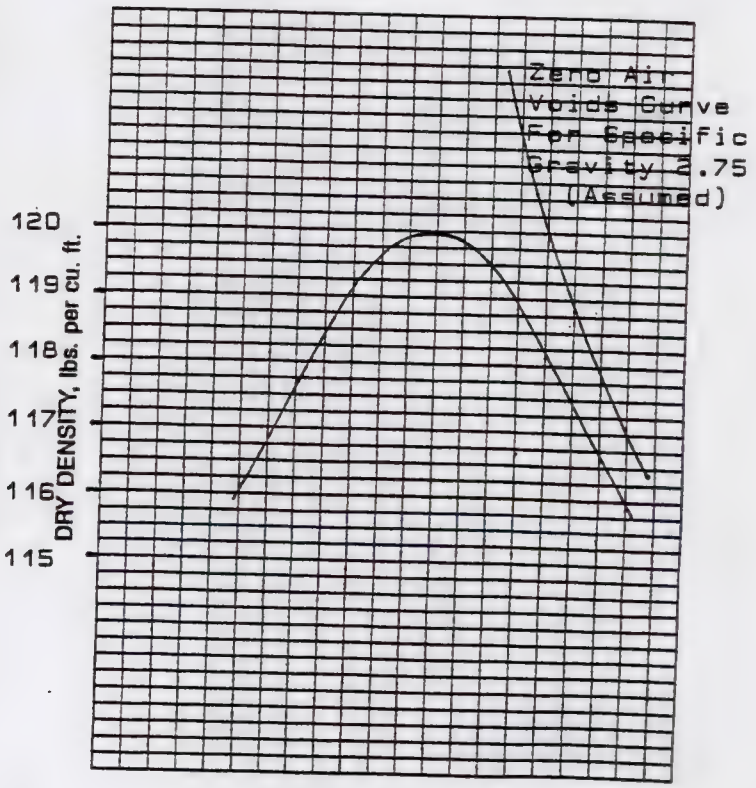
Liquid Limit
Plastic Limit Non-Plastic
Plasticity Index
Specific Gravity 2.75 (Assumed)
Texture Classification
Soil Classification Poorly graded sand, SP ASTM D2487
Test Dry Density = 114.0 pcf (95 % of 120.0)
CBR = 36 %
Test Specimen molded at 13.5 % moisture (optimum)
Test Performed at 16.3 % moisture
Remarks: Test performed using 10 lbs. surcharge.

CBR CURVE



MOISTURE-DENSITY CURVE

Method D1557-A
Max. Dry Wt. 120.0 # / Cu. Ft.
Optimum Moisture 13.5



CNI 100 Rev. 5-89

MAXIM Technologies Inc

Consulting Engineers & Scientists

CALIFORNIA BEARING RATIO DATA SHEET

Project: Stream Side Tailings
Source: HR-CBR-02
Depth:
Location:
Identification:

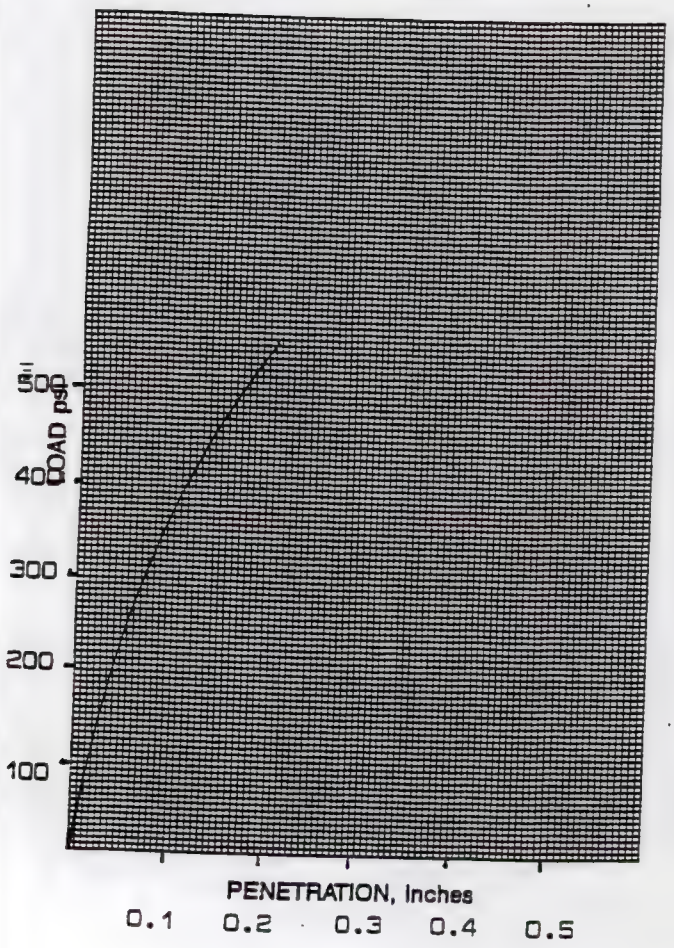
Sample No. 2452
Job No. 9731701.190
Sampled by Maxim
Date Sampled 1/28/98
Date Received 1/29/98

MECHANICAL ANALYSIS, % Pass

3" Sq.	
2" Sq.	100
1" Sq.	98
¾" Sq.	97
½" Sq.	96
3/8" Sq.	95
No. 4	90
No. 10	77
No. 20	64
No. 40	51
No. 80	30
No. 100	
No. 200	16
0.005 mm	

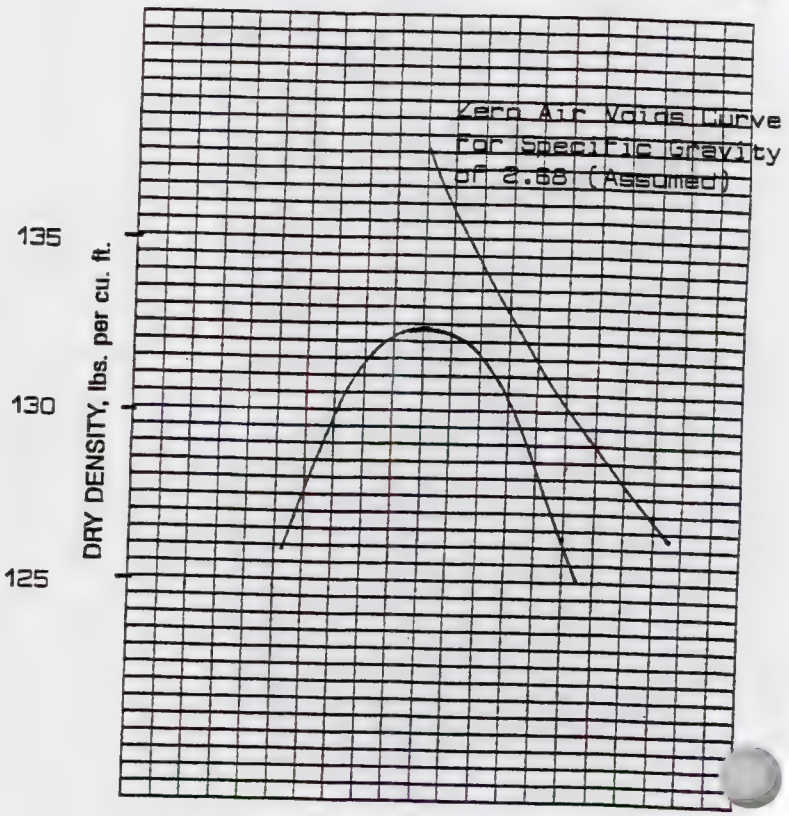
Liquid Limit
Plastic Limit Non-Plastic
Plasticity Index
Specific Gravity 2.68 (Assumed)
Texture Classification
Soil Classification Silty sand SM ASTM D2487
Test Dry Density = 125.9 pcf (95 % of 132.5)
CBR = 37 %
Test Specimen molded at 8.0 % moisture (optimum)
Test Performed at 10.2 % moisture
Remarks: Test performed using 10 lbs. surcharge.

CBR CURVE



MOISTURE-DENSITY CURVE

Method D1557A
Max. Dry Wt. 132.5 # / Cu. F
Optimum Moisture 8.0



MAXIM Technologies Inc

Consulting Engineers & Scientists

CALIFORNIA BEARING RATIO DATA SHEET

Project: Stream Side Tailings
Source: HA-CBR-03
Depth:
Location:
Identification:

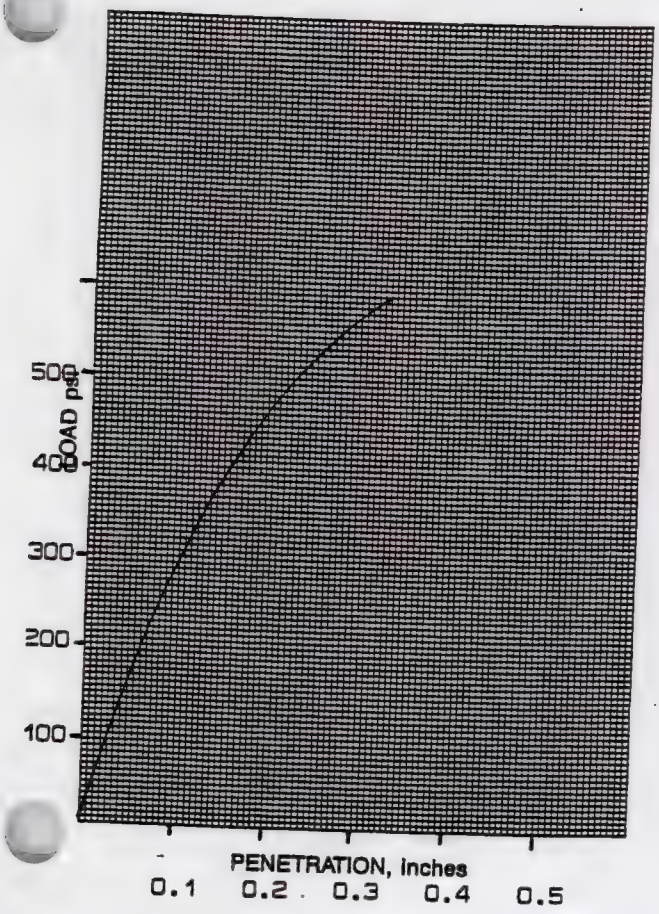
Sample No. 2453
Job No. 9731701.190
Sampled by Maxim
Date Sampled 1/28/98
Date Received 1/29/98

MECHANICAL ANALYSIS, % Pass

3" Sq.	
2" Sq.	
1" Sq.	100
¾" Sq.	99
½" Sq.	98
3/8" Sq.	97
No. 4	86
No. 10	65
No. 20	44
No. 40	25
No. 80	6
No. 100	
No. 200	1.8
0.005 mm	

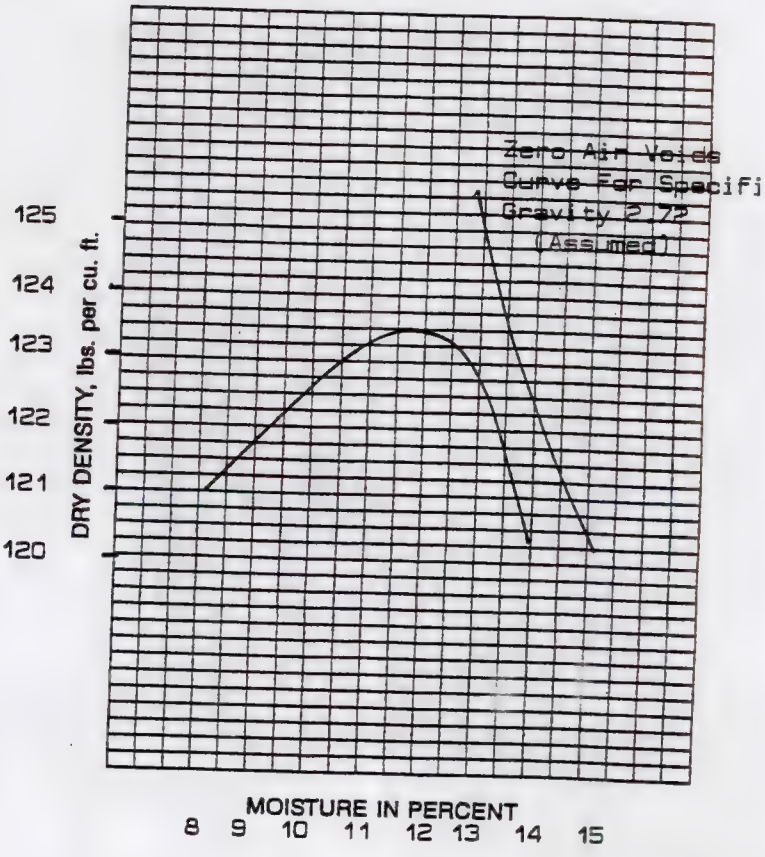
Liquid Limit
Plastic Limit Non-Plastic
Plasticity Index
Specific Gravity 2.72 (Assumed)
Texture Classification
Soil Classification Poorly graded sand, SP ASTM D2487
Test Dry Density = 117.3 pcf (95 % of 123.5)
CBR = 30 %
Test Specimen molded at 11.5 % moisture (optimum)
Test Performed at 14.1 % moisture
Remarks: Test performed using 10 lbs surcharge.

CBR CURVE



MOISTURE-DENSITY CURVE

Method D1557-A =
Max. Dry Wt. 123.5 # / Cu. Ft.
Optimum Moisture 11.5



MAXIM Technologies Inc

Consulting Engineers & Scientists

CALIFORNIA BEARING RATIO DATA SHEET

Project: Stream Side Tailings
Source: HR-CBR-04
Depth: 1.0' - 5.0'
Location:
Identification:

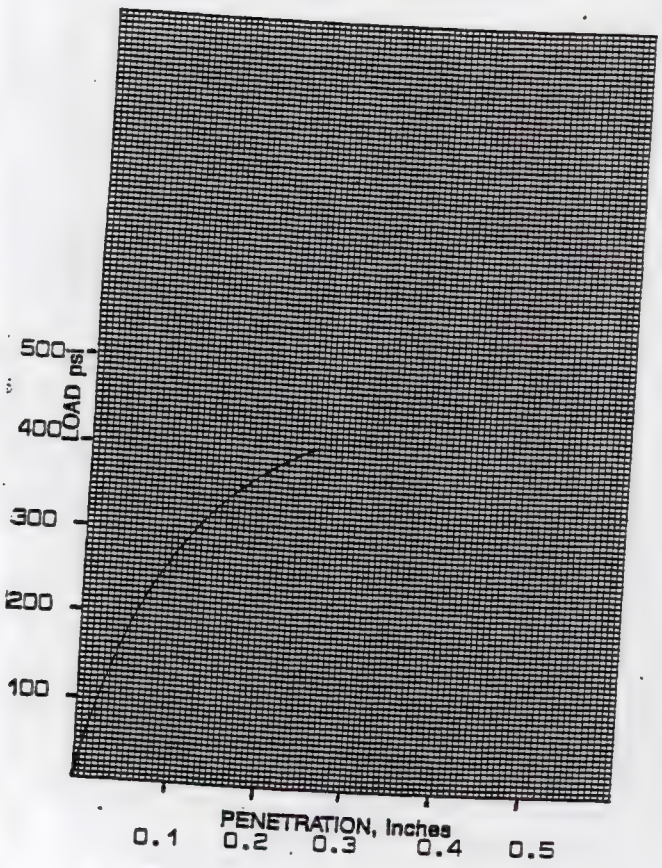
Sample No. 2454
Job No. 9731701.190
Sampled by Maxim
Date Sampled 1/28/98
Date Received 1/29/98

MECHANICAL ANALYSIS, % Pass

4"	100
3" Sq.	96
2" Sq.	93
1" Sq.	88
¾" Sq.	86
½" Sq.	84
3/8" Sq.	83
No. 4	75
No. 10	57
No. 20	43
No. 40	36
No. 80	27
No. 100	
No. 200	19
0.005 mm	

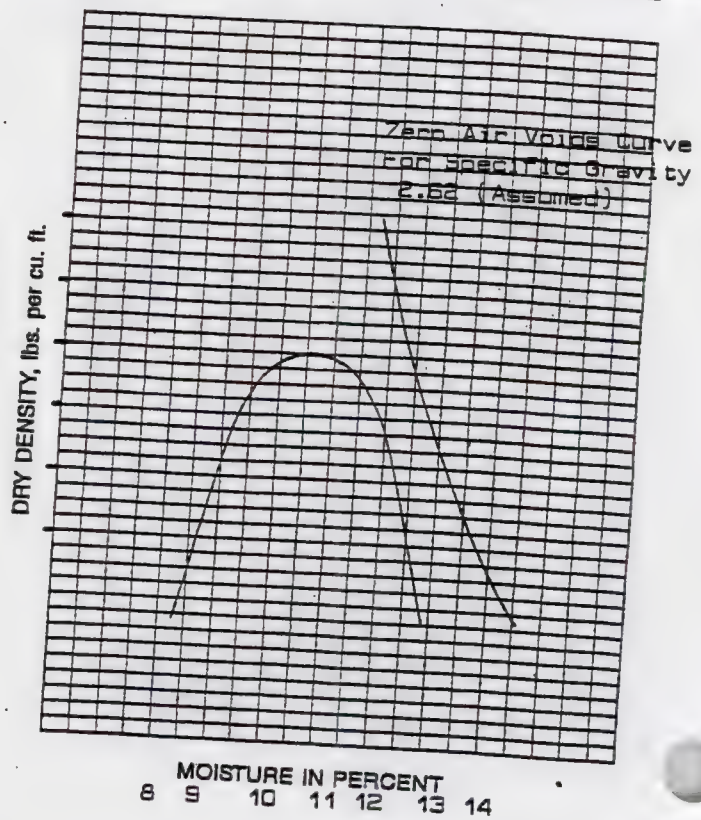
Liquid Limit 34
Plastic Limit 23
Plasticity Index 11
Specific Gravity 2.62 (Assumed)
Texture Classification
Soil Classification Clayey sand with gravel SC ASTM D2487
Test Dry Density = 116.9 pcf (95 % of 123.0)
CBR = 27 %
Test Specimen molded at 10.5 % moisture (optimum)
Test Performed at 11.9 % moisture
Remarks: Test performed using 10 lbs. surcharge.

CBR CURVE



MOISTURE-DENSITY CURVE

Method ASTM D1557-B
Max. Dry Wt. 123.0 # / Cu. Ft.
Optimum Moisture 10.5



MAXIM Technologies Inc

Consulting Engineers & Scientists

CALIFORNIA BEARING RATIO DATA SHEET

Project: Stream Side Tailings
Source: HA-CBR-05
Depth:
Location:
Identification:

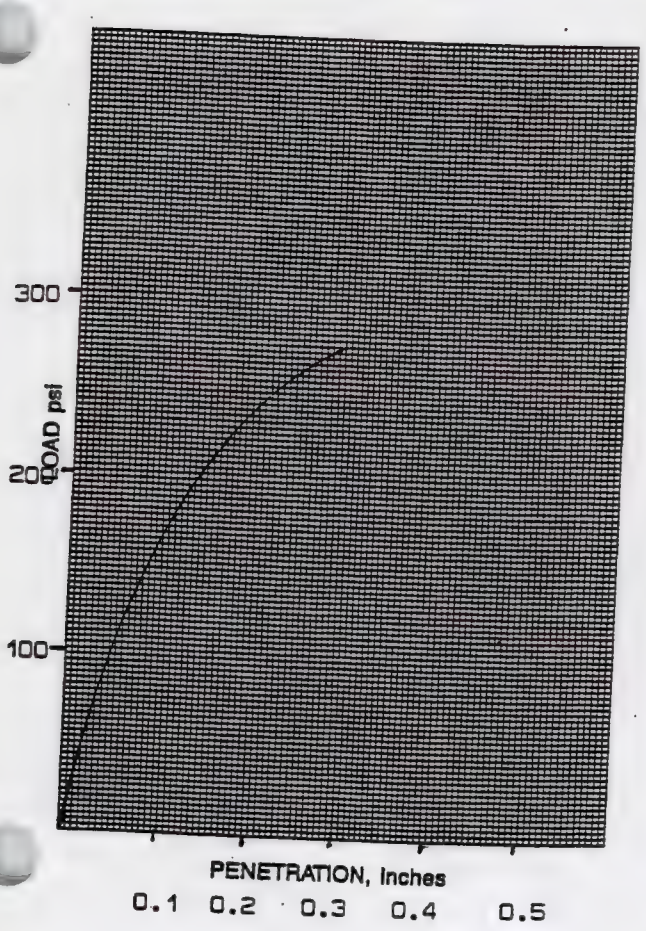
Sample No.: 2455
Job No.: 9731701.190
Sampled by: Maxim
Date Sampled: 1/28/98
Date Received: 1/29/98

MECHANICAL ANALYSIS, % Pass

3" Sq.	
2" Sq.	100
1" Sq.	99
¾" Sq.	98
½" Sq.	95
3/8" Sq.	93
No. 4	89
No. 10	84
No. 20	77
No. 40	70
No. 80	56
No. 100	
No. 200	37
0.005 mm	

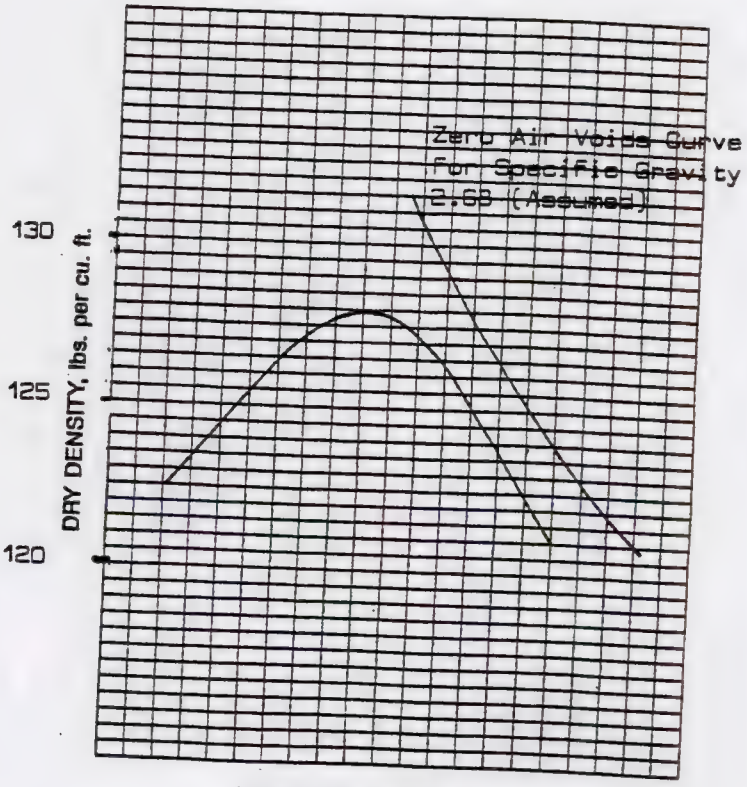
Liquid Limit: 25
Plastic Limit: 22
Plasticity Index: 3
Specific Gravity: 2.68 (Assumed)
Texture Classification:
Soil Classification: Silty sand, SM ASTM D2487
Test Dry Density = 121.6 pcf (95 % of 128.0)
CBR = 16 %
Test Specimen molded at 9.5 % moisture (optimum)
Test Performed at 12.1 % moisture
Remarks: Test performed using 10 lbs. surcharge.

CBR CURVE



MOISTURE-DENSITY CURVE

Method: ASTM D1557-A
Max. Dry Wt.: 128.0 # / Cu. Ft.
Optimum Moisture: 9.5



APPENDIX F

MINE WASTE RELOCATION REPOSITORY SUPPORTING DATA

Preliminary Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

APPENDIX F-1

Volume Estimates

MAXIM TECHNOLOGIES INC

BY B. Grant DATE 12/10/98

JOB TITLE SST-001, Reach A JOB NUMBER

SUBJECT Repository Waste Volumes SHEET 1 / 1

Calculate volume of Amended waste to be placed in MWRR-2.

B.G 3/16/99

Given: $V_{tailings}$ = ~~178,500~~ 169,100 CY — In-Place Tailings

$w_{tailings}$ = 19.7%

γ_{dry} = 95.3 lb/cf

Lime amendment rate, typical, = 52 tons CaO / 1000 tons waste

$\gamma_{d\,max}$ Amended Tailings = 109.6 lb/cf

w_{opt} = 16.9 %

Testing performed using ASTM D698

Volume if placed @ 95% of $\gamma_{d\,max}$

$W_{solids} = \frac{169{,}100}{\cancel{178{,}500}}\ CY \times \frac{27\ CF}{CY} \times 95.3\ lb/CF \times 1\ ton/2000\ lb = \frac{217{,}556}{\cancel{229{,}650}}$ tons

$W_{water} = \gamma_d \times w \times V_t = W_{solids} \times w = \frac{217{,}556}{\cancel{229{,}650}}$ tons $\times$ 0.197

$= \frac{\cancel{45{,}240}}{42{,}858}$ tons

$W_{lime\ amendment} = \frac{217{,}556}{\cancel{229{,}650}}$ tons $\times$ 52 tons CaO / 1000 tons waste

$= 11, \frac{313}{\cancel{940}}$ tons

$W_{dry,\ amended\ waste} = W_{solids} + W_{lime} = \frac{217{,}556}{\cancel{229{,}650}}$ tons + $11, \frac{313}{\cancel{940}}$ tons

$= \frac{\cancel{241{,}600}}{228{,}869}$ tons

~~$V_{amended\ waste} = \left(W_{dry,\ waste} / 0.95\ (\gamma_{dry\ max})\right)\left(\frac{1\ CY}{27\ CF}\right)$~~

~~95% of $\gamma_{d,max}$~~

~~$= \left(241{,}600\ tons \times \frac{2000\ \#}{ton} / 0.95\ (109.6)\right) \times \left(\frac{1\ CY}{27\ CF}\right)$~~

~~$= 172{,}000\ CY$ @ γ_d of 95%~~

$V_{amended\ waste} = \left(\frac{228{,}869}{\cancel{241{,}600}}\ tons \times \frac{2000\ \#}{ton} / 0.90\ (109.6)\right) \times \left(\frac{1\ CY}{27\ CF}\right)$

90% of $\gamma_{d,max}$

$= \frac{\cancel{181{,}500}}{171{,}870}$ CY @ γ_d of 90%

SST - TAILINGS IN-PLACE DENSITY FIELD SURVEY
TESTS PERFORMED ON 12/4/97
ALL TEST AT TAILINGS SURFACE

TEST LOCATION	DRY DENSITY (PCF)	WET DENSITY (PCF)	MOISTURE (%)	DRY DENSITY W/ OUT OUTLIERS (PCF)
50' S OF 1N-1013	77.6	107.6	38.7%	77.6
150' S OF 1N-1019	68.5	98.1	43.2%	68.5
100' SE OF 1N-1025	74.4	101.4	36.3%	74.4
100' SW OF 1N-1029	54.8	84.6	54.4%	
15' W OF 1N-1038	84.8	101.2	19.3%	84.8
100' E OF 1N-1041	85.7	99.0	15.5%	85.7
30' W OF 1S-1051	115.3	119.4	3.6%	115.3
40' N OF 1S-1075	104.9	117.3	11.8%	104.9
50' NE OF 1S-1087	111.8	115.6	3.4%	111.8
50' S OF 1N-1092	100.9	107.8	6.8%	100.9
100' E OF 1S-1098	104.5	119.5	14.4%	104.5
50' NE OF 1S-1116	89.4	111.2	24.4%	89.4
100' S OF 1N-1131	75.3	100.3	33.2%	75.3
100' W OF 1N-1128	79.3	106.4	34.2%	79.3
30' NE OF 1N-1143	118.5	128.1	8.1%	118.5
100' NE OF 1DN-7002	86.1	104.0	20.8%	86.1
100' N OF 1DS-7009	70.2	88.2	25.6%	70.2
50' N OF 1DN-7024	96.7	102.0	5.5%	96.7
50' NW OF 1DN-7025	79.5	97.7	22.9%	79.5
200' E OF 1DN-7036	83.2	100.6	20.9%	83.2
50' S OF 1N-1178	109.5	112.3	2.6%	109.5
40' S OF 1N-1187	110.6	118.0	6.7%	110.6
50' S OF 1N-1196	80.1	100.8	25.8%	80.1
10' N OF 1S-1221	120.9	124.1	2.6%	120.9
10' N OF 1N-1228	90.9	113.6	25.0%	90.9
60' N OF 1S-1231	114.5	119.7	4.5%	114.5
100' N OF 1S-1259	59.0	95.5	61.9%	
100' N OF 1S-1263	92.1	120.7	31.1%	92.1
100' N OF 1S-1264	107.8	112.9	4.7%	107.8
150' NW OF 1S-1265	100.1	125.8	25.7%	100.1
50' SE OF 1N-1275	110.2	121.0	9.8%	110.2
200' NW OF 1S-1278	120.3	125.0	3.9%	120.3
100' NW OF 1S-1280	83.6	98.9	18.3%	83.6
60' NW OF 1N-1281	81.0	98.5	21.6%	81
60' SW OF 1N-1285	87.6	109.3	24.8%	87.6
100' SW OF 1N-1289	92.6	114.5	23.7%	92.6
225' W OF 1S-1293	109.3	119.1	9.0%	109.3
75' S OF 1N-1297	73.2	94.2	28.7%	73.2
25' S OF 1N-5015	122.1	127.3	4.3%	122.1
50' W OF 1S-1005	109.3	122.4	12.0%	109.3
AVERAGES	93.40	109.59	19.74%	

AVERAGE W/ OUT OUTLIERS 95.32

in-place dens

DENSITIES LOWER THAN 62.4 (WATER) NOT INCLUDED. SUBSURFACE VOIDS ENCOUNTERED.

MOISTURE-DENSITY RELATIONSHIP TEST

Test specification: ASTM D 698-91 Procedure A, Standard
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
				2.65			0 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 109.6 pcf Optimum moisture = 16.9 %	109.6 pcf 16.9 %	Amended Line Kiln Dust and Tailings Composite

Project No.: 9231701
Project: MT. DEPT. OF ENV. QUALITY
Location:

Date: 2-08-1998

Remarks:

MOISTURE-DENSITY RELATIONSHIP TEST

MAXIM Technologies, Inc.

Fig. No. 1

PROJECT: SST, subarea 1
DESIGNER: B. Grant
DATE: 12/03/98

COMMENTS: **MWRR-2** Revised Layout 12/03/98

CONSTANTS/FACTORS

waste rock density =>	100	pcf
side slopes=>	4:1	
drawing scale, per inch=>	100	ft
planimeter conversion, per unit=	1	inch

REPOSITORY CAPACITY

Elev.	Lift Thickness (ft)	Lift Area planimeter units	Surface Area (k sq.ft.)	Avg. Lift Area (k sq.ft.)	Lift Volume (k cy)	Cumulative Volume (k cy)
5420		0	0			0.0
5430	0	0.5	5	2.5	0.00	0.0
5440	10	5.1	51	28	10.37	10.4
5450	10	9.2	92	71.5	26.48	36.9
5460	10	13	130	111	41.11	78.0
5470	10	14.6	146	138	51.11	129.1
5480	10	12.2	122	126	46.67	175.7
5490	10	8	80	101	37.41	213.1
5500	0	0	0	40	0.00	213.1
	0	0	0	0	0.00	213.1
	0	0	0	0	0.00	213.1
	0	0	0	0	0.00	213.1
	0	0	0	0	0.00	213.1
	0	0	0	0	0.00	213.1

Area of footprint containing waste = 33.6 square inches haul road

Soil salvage = $0.5' \times (33.6\ in^2 + 5\ in^2)\left(\frac{100^2\ ft^2}{in^2}\right) \times \frac{1\ cy}{27\ cf} = 7,150\ cy$

Cover soil = $1.8' \times (33.6\ in^2)\left(\frac{100^2\ ft^2}{in^2}\right) \times \frac{1\ cy}{27\ cf} = 22,400\ cy$

Imported Cover Soil = 22,400 cy - 7,150 cy = 15,250 cy

Total Waste Storage Volume

213,000 cy + 7,150 cy - 22,400 cy = 197,750 cy

Relocate
Drainage
Between Arrows

Relocate
Power Line

Haul Route

SIT-001, MURR-2
Repository Volume Calc.
B. Grant 12/13/88

Elev	Area (in²)
5430	0.5
5440	5.1
5450	9.2
5460	13.0
5470	14.6
5480	12.2
5490	8.0

Area of footprint containing waste = 22.6 in²

1" = 100'

5530

5427

5432

5422

Topsoil Stockpile (4,530 cyr

5430

Install Culverts Beneath
Highway at Locations Shown

Construction
Sediment
Pond

Protect Existing
Utilities From Damage

Construct Haul Route

5418.4'

Relocate
Drainage
Between Arrows

Relocate
Power Line

SST-Out, MWR-2
Repository Volume Calc
B. Grant 12/3/99

Elev	Area (in²)
5430	0.5
5440	5.1
5450	9.2
5460	13.0
5470	14.6
5480	12.2
5490	8.0

Area of footprint containing waste = 33.6 in²

1" = 100'

5500
5440
5432
5427
5422
5418.4

Topsoil Stockpile (4 530 cyr

Install Culverts Beneath
Highway at Locations Shown

Construction
Sediment
Pond

Protect Existing
Utilities From Damage

Construct Haul Route

Haul Route

Burn A

APPENDIX F-2

Erosion Calculations

MAXIM TECHNOLOGIES INC

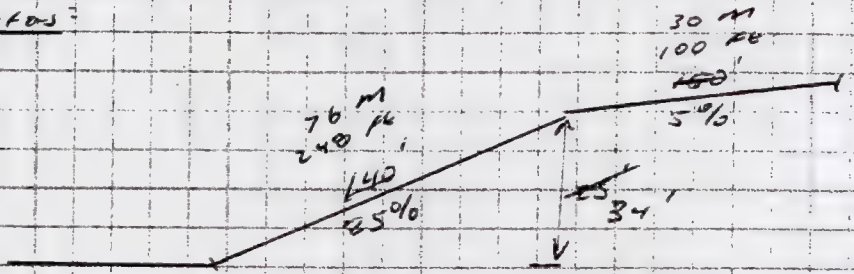
BY BRG DATE 12/3/98 2/25/99

JOB TITLE UST-001, MuRR-2 JOB NUMBER

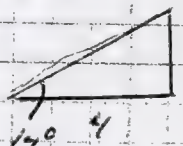
SUBJECT Soil Loss calculations SHEET 1

Purpose: Determine Estimate soil loss rate for repository design

Parameters:



Repository Slopes



$\sin 14° = \frac{34}{r}$ 60

$r = \frac{34}{\sin 14°} 60$

$= \frac{140'}{248 ft}$

Calculation:

Soil Loss Equation $A = (R)(K)(LS)(C)(P)$

R = Erosivity Factor

= 20 Source: Figure 2.1 Kirkby & Morgan - 1980

K = Soil Erodibility Factor

= 0.24 Source: Kirkby & Morgan - 1980, Figure 2.6

LS = Slope Length Factor

9.9

= ~~20~~ See Sheet 2

C = Cropping Factor

0.05

= ~~0.25~~ Source: Table 2.8, 25% slope, Period 2 Fast Growing Grass; Kirkby & Morgan 1980

P = Erosion Control Practice

= 0.9 Source: Table 2.10 Contour Seeding/mulching; Kirkby & Morgan 1980

MAXIM TECHNOLOGIES INC

BY BRG DATE 2/25/98

JOB TITLE SJT-001, Mu RR-2 JOB NUMBER

SUBJECT Soil Loss Calculations SHEET 2

$A = (R)(k)(LS)(C)(P)$

$= (20)(0.24)(7.0)(0.005)(0.9)$

$= 1.5$ tons/acre/year

LS Calculations for McFarland Ranch Project - Composite Slopes Based on RUSLE

Slope No.	Slope %	λ_j	$L_{cum,j}$	x_j	x_{j-1}	m	α_j	α_{j-1}	$(\alpha_j - \alpha_{j-1})$
(1)	5	0.454	30 m	30 m	0	0.5	30.1	0	30.1
(2)	25	0.226	45 m	106 m	30 m	0.5	93.9	30.1	63.8
			$\lambda_c = 89$ m						Σ 620

$LS_j = \frac{0.43 + 0.30x_j + 0.043x_j^2}{6.613}$

(1) $\alpha_j = \frac{\lambda_j}{22.13^m}$ $LS_j = \frac{x_j^{m+1} - x_{j-1}^{m+1}}{22.13^{0.5} \times x_j}$ $\alpha_{j-1} = \frac{\lambda_{j-1}}{22.13^m}$

$\alpha_j = \frac{30}{22.13^{0.5}} = 6.38$ $LS_j = \frac{30^{1.5} - 0^{1.5}}{22.13^{0.5} \times 30} = 1.5$ $\alpha_{j-1} = \frac{0}{22.13^{0.5}} = 0$

(2) $\alpha_j = \frac{5.26 \times 89}{22.13^{0.5}} = 99.6$ $LS_j = \frac{89^{1.5} - 30^{1.5}}{22.13^{0.5} \times 89} = 4.20$ $\alpha_{j-1} = \frac{5.26 \times 30}{22.13^{0.5}} = 33.5$

$LS = \sum_{j=1}^{n} \left(\frac{\alpha_j^{m+1} - \alpha_{j-1}^{m+1}}{x_j^{m+1} \times 22.13^m} \right)$

$= \left(\frac{99.6^{1.5} - 0}{89^{1.5} \times 106} \right) + \left(\frac{1220 - 184}{89^{1.5} \times 106} \right) = 9.9$

LANDSCAPE SYSTEMS

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Soil Erosion

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watersheds. Lloyd and Eley (1952) provided a graphical solution of the Musgrave equation for use in the Northeastern United States.

A disadvantage to the steepness of slope evaluation by Zingg (1940) was that the soil loss from slopes less than four per cent was underpredicted and zero soil loss was computed for a zero per cent slope. Smith and Whitt (1947, 1948) proposed an equation of the form:

$$A = a + bS^n \tag{2.3}$$

to describe the effect of slope on soil loss. They also presented a method of estimating soil loss for the claypan soils of Missouri using the effects of slope steepness, length of slope, crop rotations, conservation practices, and soil groups. The equation presented was:

$$A = CSLKP \tag{2.4}$$

where:

A = the average annual soil loss,
C = the average annual rotation soil loss from plots, and
S, L, K and P = are multipliers to adjust the plot soil loss C for slope steepness, length, soil group, and supporting conservation practice, respectively.

It is interesting to note that this equation is similar in form to the Universal Soil Loss Equation introduced 11 years later. However, Equation (2.4) does not contain a separate rainfall factor. Van Doren and Bartelli (1956) evaluated the factors affecting soil loss for Illinois soils and conditions. Their soil loss estimation procedure provided two factor tables; one that included the effects of soil type, slope steepness, slope length, and mechanical practices, and a second that included soil erodibility effects, previous erosion, crop rotation, management, and intensity and frequency of 30-minute rainfall.

In 1954 soil erosion prediction research was consolidated in a cooperative effort aimed at overcoming many of the disadvantages inherent in local or regionalized research projects. More than 8000 plot-years of erosion research data were compiled from 36 locations in 21 states. A re-evaluation of the various factors affecting soil loss (Smith and Wischmeier, 1957; Wischmeier and Smith, 1958; and Wischmeier *et al.*, 1958) was made which led to development of the widely used soil loss prediction method called the Universal Soil Loss Equation.

Concurrently, Hudson (1961) presented an erosion equation:

$$E = TSLPMR \tag{2.5}$$

where E is erosion and the remaining factors are functions of soil type, slope gradient, and length, agronomic or agricultural practice, mechanical protection, and rainfall, respectively. The problems of adequately evaluating each of these factors were discussed by Hudson and he reported on extensive research

on the erosivity of rainfall in the sub-tropics of Africa. Equation (2.5) is identical in concept to the Universal Soil Loss Equation.

Elwell (1977) developed a Soil Loss Estimation System for Southern Africa:

$$Z = KCX \tag{2.6}$$

where:

Z = predicted mean annual soil loss,
K = mean annual soil loss, from a standard field plot 30 m × 10 m at a 4.5 per cent slope for a soil of known erodibility under bare fallow,
C = the ratio of soil lost from a cropped plot to that lost from the standard plot, and
X = the ratio of soil lost from a plot of length L and slope S to that lost from the standard plot.

The K factor is dependent on rainfall kinetic energy and soil erodibility. The The soil erodibility index is defined by basic soil type and may be adjusted for permeability, structure, and conservation practices. The crop cover factor, C, is a function of the percentage rainfall energy intercepted which is determined from a crop cover distribution curve for the assumed crop and the distribution of rainfall energy. The X factor is the same as the LS factor of the Universal Soil Loss Equation.

The development of prediction equations was of necessity evolutionary in nature. The predominantly qualitative descriptions led to the evaluation of one or two factors that could be quantified with the data from a locale or region. The evolutionary process continued with additional factors being quantified as more data were obtained. The consolidation of data from many stations enabled researchers to develop prediction equations applicable to a region or a number of regions. Each of the predictive techniques was limited in its applicability by the limits of the data from which it was developed. Hence, it was usually useful only for a local area, specific soil type, or perhaps a region. As more data sources became available, more conditions could be estimated and the area of applicability expanded. The centralization of data led to an equation widely accepted in the United States and which has been adopted world-wide.

2.2 THE UNIVERSAL SOIL LOSS EQUATION

The most widely used method of soil loss prediction by conservationists in the United States is the Universal Soil Loss Equation (USLE):

$$A = (0.224)RKLSCP \tag{2.7}$$

where:

A = the soil loss, kg/m^{2}s,
R = the rainfall erosivity factor,

K = the soil erodibility factor,
L = the slope length factor,
S = the slope gradient factor,
C = the cropping management factor, and
P = the erosion control practice factor.

The USLE is also being adapted for soil loss estimation in other countries as will be discussed throughout the description of the elements of the equation.

Equation (2.7) was designated 'universal' because it was free of some of the generalizations and geographic and climatic restrictions inherent in earlier models. It has been criticized as not being universal because parameter values were presented for conditions of the eastern two-thirds of the United States. However, as data are accumulated, parameters are being identified for use in more areas, including regions in other continents.

The USLE was developed as a method to predict average annual soil loss from interrill and rill erosion. With the parameter values available, cropping and management alternatives can be determined to reduce the estimated soil loss to suggested tolerance values for the soil type. As detailed by Wischmeier (1976) the USLE may properly be used to:

(1) predict average annual soil loss from a field slope with specific land use conditions,
(2) guide the selection of cropping and management systems, and conservation practices for specific soils and slopes,
(3) predict the change in soil loss that would result from a change in cropping or conservation practices on a specific field,
(4) determine how conservation practices may be applied or altered to allow more intensive cultivation,
(5) estimate soil losses from land use areas other than agricultural, and
(6) provide soil loss estimates for conservationists to use for determining conservation needs.

Although the USLE was primarily designed as a convenient aid for conservation planning it may also be a useful research tool provided one is more precise in evaluating the equation factors than for conservation planning. It can be used to generate soil loss data for correlation with other parameters. The equation was developed to estimate long-term average annual soil loss. Therefore, its application to a specific year or storm may not be appropriate. When used with a specific storm it will estimate the average soil loss for numerous recurrences of that event and, as with any average, the soil loss from any one of these events may vary considerably. Applying the equation to situations for which factor values are not yet determined is especially dangerous. Although expedient and often necessary for conservation planning purposes, extrapolation is always hazardous.

The factors of the USLE were developed using an evaluation unit called the standard plot. A standard plot is 22.13 metres long on a uniform lengthwise slope of 9 per cent. The plot was tilled up and down slope and was in continuous fallow for at least two years. The standard plot is simply a result of the historical development of the USLE. Early basic data were often obtained from plots 40.5 m^2 (0.01 acre) in size. For a convenient width of 1.83 metres (6 ft) this gave a plot length of 22.13 metres (72.6 ft). Much of the data were taken from surfaces that deviated from the standard plot and provided the ranges for the statistical analysis that lead to the development of the USLE. However, the standard plot was used as the basis for defining the variation in L, S, C, and P.

Aside from the general considerations of the USLE, specific uses and limitations are presented with the discussion of each factor. The development and evaluation of each factor of the equation are presented in the following subsections.

2.2.1 The rainfall erosivity factor, R

The rainfall erosivity factor in the USLE is the rainfall erosion index as presented by Wischmeier (1959). The R factor is a definition of the erosivity of rainfall events and is defined as the product of two rainstorm characteristics: kinetic energy and the maximum 30 minute intensity.

Wischmeier and Smith (1958) analysed drop size distribution data published by Laws and Parson (1943) and rain drop terminal velocity reports by several researchers. A regression equation describing the kinetic energy of a rainstorm or portion of a rainfall event was developed:

$$E = 1.213 + 0.890 \log_{10} I \qquad (2.8)$$

where:

E = the kinetic energy, kg m/m^2 mm, and ...
I = rainfall intensity, mm per hour.

The kinetic energy for an intensity increment is obtained by multiplying the kinetic energy from Equation (2.8) by the rainfall amount for that intensity increment. The total energy, in kg m/m^2, for a rainfall event can be computed by accumulating the kinetic energy for each distinct intensity increment of the event.

Regression analyses showed that storm soil losses from cultivated continuous fallow plots were highly correlated to the cross-product of the total kinetic energy and the maximum 30-minute rainfall intensity (Wischmeier, 1959). This product, designated by EI, is a measure of the manner in which energy and intensity are combined in a storm and defines the combined effects of raindrop impact and turbulence of runoff to transport soil particles from a field. The rainfall erosivity factor, R, is obtained by dividing the EI product by 173.6

The computation of the rainfall erosivity factor, R, for a storm is defined by:

$$R = \frac{\left[\sum_{j=1}^{n} (1.213 + 0.890 \log_{10} I_j)(I_j T_j)\right] I_{30}}{(173.6)} \qquad (2.9)$$

where:

R = the rainfall erosivity index,
I_j = the rainfall intensity for a specific storm increment, mm/hr,
T_j = the time period of the specific storm increment, hr,
I_{30} = the maximum 30-minute rainfall intensity for the storm, mm/hr,
j = the specific storm increment, and
n = the number of storm increments.

Although there are units associated with the R factor, the USLE is not dimensionally correct without assuming units for the K factor. For this presentation the conversion from English units to SI units has been done simply by converting the original English unit equations. Although the units for intensity in Equation (2.9) are SI the R factor value is identical to the value one would obtain if the equivalent English units were used with the traditional equation (Wischmeier and Smith, 1965). This procedure has the advantage of not requiring conversion of existing R and K factor tables and maps.

The rainfall erosivity indexes can be summed for any time period to provide a numerical measure of the erosivity of the rainfall during that period. The

Figure 2.1. Average annual values of the rainfall-erosivity factor, R, for the USA

reduction of long-term rainfall records provides average annual values of the rainfall erosivity index or rainfall factor, R. These rainfall factor values for a large area can be presented as curves of equal erosivity (iso-erodents) on a map of the area of interest.

Studies have shown that the median dropsize of rainfall does not continue to increase with rainfall intensities above 76.2 mm/hr (Carter *et al.*, 1974; Hudson, 1971). Therefore, current recommendations (Wischmeier and Smith, 1978) are that a limit of 76.2 mm/hr be used in the computation of energy per unit of rainfall by Equation (2.8). Also, it is recommended that a limit of 63.5 mm/hr be placed on the I_{30} component of Equation (2.9).

Average annual R values for the contiguous United States are shown in Figure 2.1. A more detailed map of R values has recently been presented by Wischmeier and Smith (1978). It is recommended that the Soil Conservation Service Technical Center, Portland, Oregon, be contacted for specific recommendations for locations in the shaded region of the west and northwest. Average annual values of the rainfall-erosivity factor, R, for Hawaii are shown in Figure 2.2.

For any hydrologic evaluation there is an associated annual distribution of the phenomena being investigated. Because the rainfall factor, R, does not completely describe the differences in the effect of rainfall pattern on soil erosion due to location, the area east of the 104° meridian in the United States was

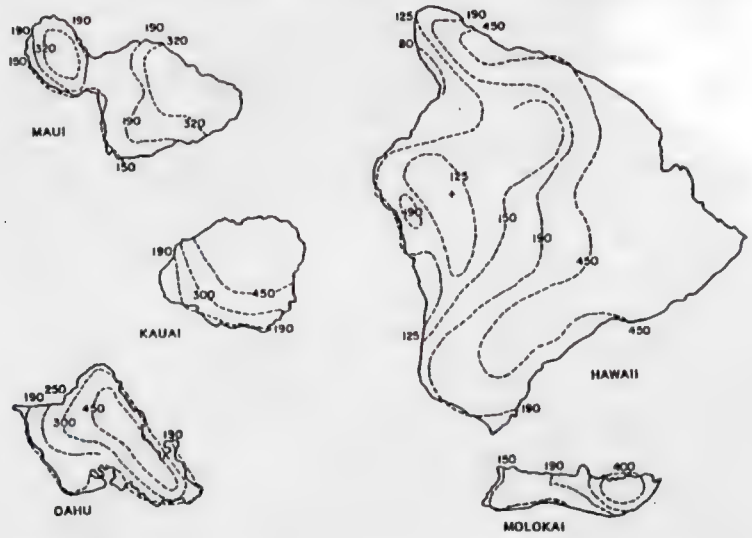


Figure 2.2. Estimated average annual values of the rainfall-erosivity factor, R, in Hawaii (ARS, 1975)

divided into 33 geographic areas and a distribution curve presented for each area (Wischmeier and Smith, 1965). The monthly and annual distribution for each area are different for some portion of the distribution curve. Typical distribution curves are shown in Figure 2.3 for three areas. These distributions are used with detailed cropping management data to obtain seasonal cropping factors or to combine crop rotation information as described in Section 2.2.4.

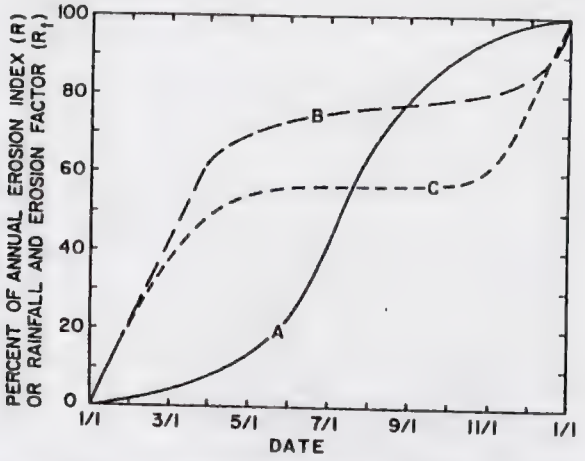


Figure 2.3. Distribution curves of erosion-index, *R*, for: (A) Central corn belt (northern Missouri and central Illinois, Indiana, and Ohio) (Wischmeier and Smith, 1965); (B) Dryland grain region of the Pacific Northwest, tentative (McCool *et al.*, 1977) (Reproduced by permission of SCSA); and (C) South Central part of Island of Molakai (USSCS, 1976)

The average annual *R* values are determined from data with a wide scatter of both storm and annual erosivity values. The annual erosion index was evaluated at 181 locations for 50, 20, and 5 per cent annual probabilities. Also, 1, 2, 5, 10, and 20 year recurrence interval values of the *R* factor for individual storms were evaluated. Sample probabilities and recurrence intervals are listed in Table 2.1. Annual distributions and probabilities and storm recurrence interval information may be compiled for any location of interest from long-term precipitation records. Standard hydrologic probability evaluations can be applied to erosion index values in the same way they are used with other hydrologic phenomenon.

Additional methods of defining an erosion factor have been proposed to

Table 2.1. Probability values of erosion index *R*, for central corn belt, USA*

Location	Probability values of annual erosion index (EI)			Single event index values normally exceeded once in				
	50 per cent	20 per cent	5 per cent	1 year	2 years	5 years	10 years	20 years
Illinois:								
Moline	158	221	303	39	59	89	116	145
Rantoul	152	201	263	27	39	56	69	82
Springfield	154	210	283	36	52	75	94	117
Indiana:								
Fort Wayne	127	183	259	24	33	45	56	65
Indianapolis	166	225	302	29	41	60	75	90
Terre Haute	190	273	389	42	57	78	96	113
Missouri:								
Columbia	214	297	406	43	58	77	93	107
Kansas City	170	248	356	30	43	63	78	93
Rolla	209	287	387	43	63	91	115	140
St. Louis	168	290	488	45	62	86	106	126
Ohio:								
Cincinnati	146	211	299	27	36	48	59	69
Columbus	113	158	216	27	40	60	77	94
Coshocton	158	235	343	27	45	77	108	143
Dayton	125	175	240	21	30	44	57	70

* From Wischmeier and Smith, 1965.

simplify the original method and to obtain R values more applicable to regional conditions. Studies by the United States Agricultural Research Service (Wischmeier, 1974) and the United States Environmental Protection Agency (Ateshian, 1974; EPA, 1973) were directed toward correlating the rainfall erosion index with various rainfall intensity–duration–frequency information. Equations were developed whereby the erosion index can be obtained from the 2-year, 6-hour duration rainfall for the two rainfall distribution types defined by the United States Soil Conservation Service (1973) in their runoff estimation procedures. The United States Soil Conservation Service (1975) also defined a third rainfall distribution type and Woodward (1975) presented the erosion index equation for that condition. These equations for the average annual erosion index are:

$$\text{Type IA: } R = 0.00829\, P_{2,6}^{2.2} \tag{2.10}$$

$$\text{Type I: } R = 0.0134\, P_{2,6}^{2.2} \tag{2.11}$$

$$\text{Type II: } R = 0.0245\, P_{2,6}^{2.17} \tag{2.12}$$

where:

R = the rainfall erosion index, and
$P_{2,6}$ = the 2-year recurrence interval, 6-hour duration rainfall, mm.

Type IA storm distribution is characteristic of the coastal side of the Cascade and Sierra Nevada Mountains in Oregon, Washington, and Northern California, and the coastal regions of Alaska. Type I is applicable to the coastal side of the Sierra Nevada Mountains in Southern California, to Hawaii, and to the interior regions of Alaska. Type IA and I storm distributions are representative of maritime climates with wet winters and dry summers. Type II storm distribution is characteristic of the intense storms that occur over the remainder of the United States, Puerto Rico, and the Virgin Islands. Wischmeier (1974) cautions against using Equations (2.10)–(2.12) if more detailed data are available. The equations and the 2-year, 6-hour rainfall amounts are both subject to estimation errors. Values of EI computed directly or obtained from iso-erodent maps developed from direct computation are preferable to those derived from empirical equations.

Ateshian (1974) also developed equations for Type I and II storms for 2-year recurrence interval storms of duration to 24-hours. The equations describing the individual storm erosion index are:

$$\text{Type I: } R_I = 0.0122\, P^{2.2}/H^{0.6065} \tag{2.13}$$

$$\text{Type II: } R_I = 0.0156\, P^{2.2}/H^{0.4672} \tag{2.14}$$

where:

R_I = individual storm erosion index,
P = storm rainfall depth, mm, for 2-year recurrence interval and duration as specified by H, and
H = duration of storm, hours.

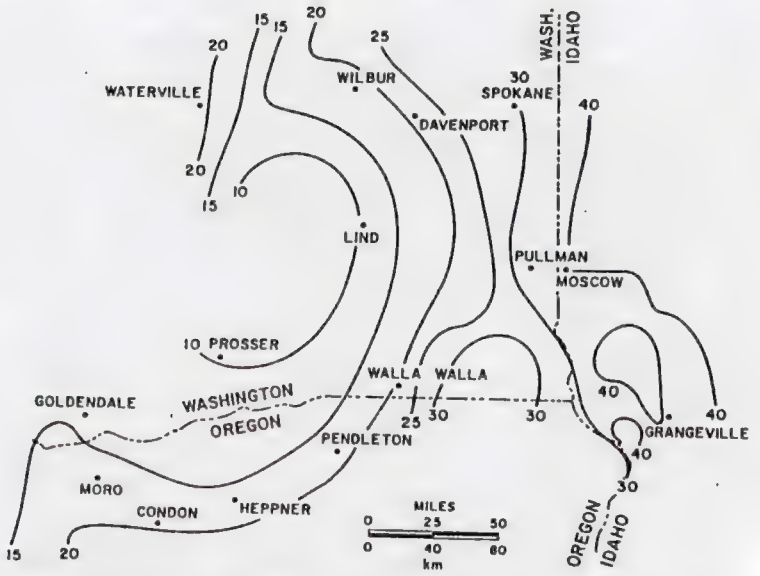


Figure 2.4. Tentative rainfall and runoff erosivity factor for the dryland grain region of the United States Pacific Northwest (McCool *et al.*, 1977) (Reproduced by permission of SCSA)

The special conditions of the dryland grain region of the United States Pacific Northwest were examined by McCool *et al.* (1974, 1976). For this region, defined by Figure 2.4, soil loss was found to be correlated with the December through March precipitation. This discovery lead to a compromise relationship of:

$$R_T = 0.0245\, P_{2,6}^{2.17} + 0.0591\, P_{(D-M)} \tag{2.15}$$

where:

R_T = the 'rainfall and runoff' erosivity factor,
$P_{2,6}$ = the 2-year recurrence interval, 6-hour duration rainfall, mm, and
$P_{(D-M)}$ = the December through March precipitation, mm.

A comparison of R values for the region defined by Figure 2.4 and the same portion of Figure 2.1 indicates as much as a two-fold increase in the R factor using Equation (2.15). The distribution curve for this region (Figure 2.3) shows that the major erosion potential is obviously in the winter months and occurs in the form of low intensity rainfall or snow. This low intensity precipitation does not increase the R value defined by Equation (2.9) sufficiently but is a significant erosion agent in the region.

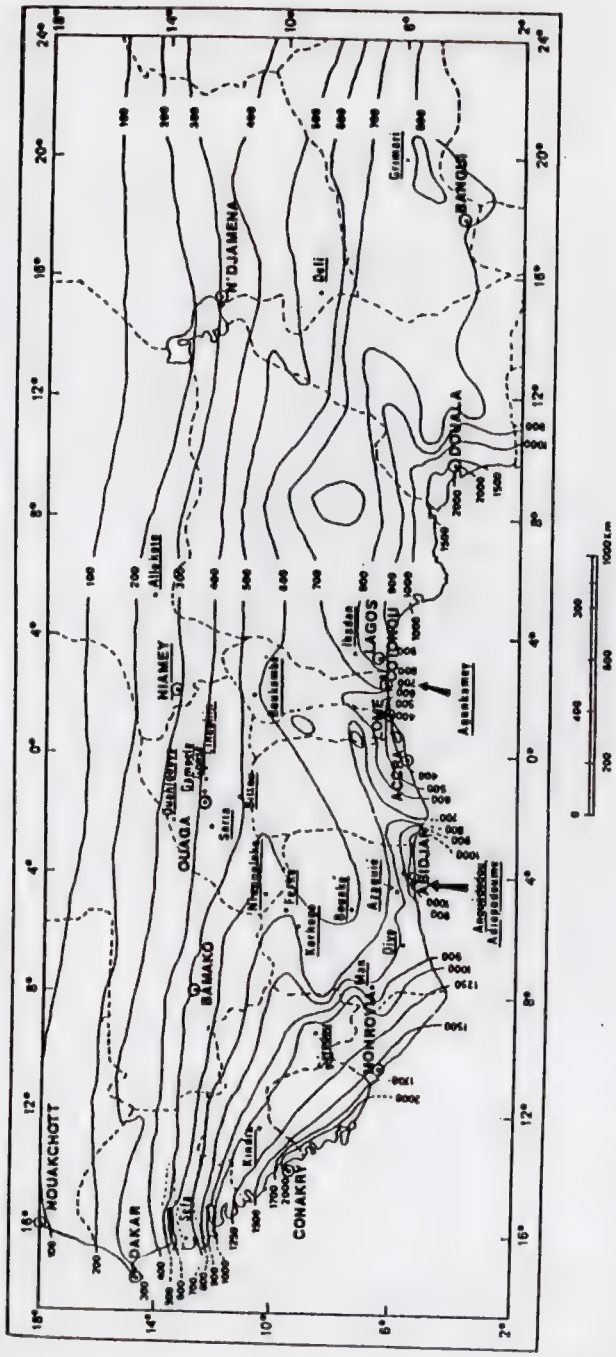


Figure 2.5. Average annual values of the rainfall-erosivity factor, R, in West Africa (Roose, 1977) (Reproduced by permission of OSTROM and SCSA)

Recent studies have shown that thaw and snowmelt runoff erosion are significant. In areas of the United States where this is the case, current recommendations (Wischmeier and Smith, 1978) are that an R_s factor equal to 0.0591 times the December-through-March precipitation (mm) be added to the R factor value computed by Equation (2.9).

Average annual R values for a large part of West Africa were developed by Roose (1977). A detailed study of the correlation between daily rainfall and the rainfall erosivity index was conducted that resulted in a single empirical relationship:

$$R_{an}/H_{an} = 0.50 \pm 0.05 \tag{2.16}$$

where:

R_{an} = average annual erosivity index, and
H_{an} = average annual rainfall amount, mm.

This relationship was found appropriate to several recording stations in Ivory Coast, Upper Volta, Senegal, Niger, and Tchad. Roose stated that the iso-erodent map (Figure 2.5) has sufficient precision (5 per cent), outside the mountainous and coastal zones, to permit use of the USLE in West Africa.

Iso-erodent maps for Tunisia (Masson, 1972) and the Tet River basin in southern France (Masson, 1976) have been developed as well as erosion index distribution curves for those areas. In an earlier study, Cormary and Masson (1964) described the USLE factor evaluations for Tunisia. Equations relating the USLE erosivity factor, R, to local precipitation amount and intensity were developed by Delwaulle (1973) for Niger. Bailly *et al.* (1976) divided Madagascar into regions and presented equations to determine rainfall energy from precipitation amount for each region.

Hudson (1971) conducted extensive soil erosion studies on soils in subtropical Africa. He found that soil loss was most closely correlated to the kinetic energy of individual storms of 25.4 mm (1 in) per hour and greater intensity. He described this parameter as the KE > 25 index.

Several authors have discussed the problems of determining an adequate rainfall erosivity index for areas outside of those for which the USLE was developed. Renard and Simanton (1975) describe the large variability in computed EI values between locales relatively close together affected primarily by high intensity, short duration orographic storms. Preliminary studies by Singer *et al.* (1977) indicate that the soil loss estimate using EI values is too large for low intensity rainfall of California rangelands. They point out that more data are needed to verify this indication.

2.2.2 The soil erodibility factor, K

The soil erodibility factor, K, in the USLE is a quantitative description of the inherent erodibility of a particular soil. This factor reflects the fact that differ-

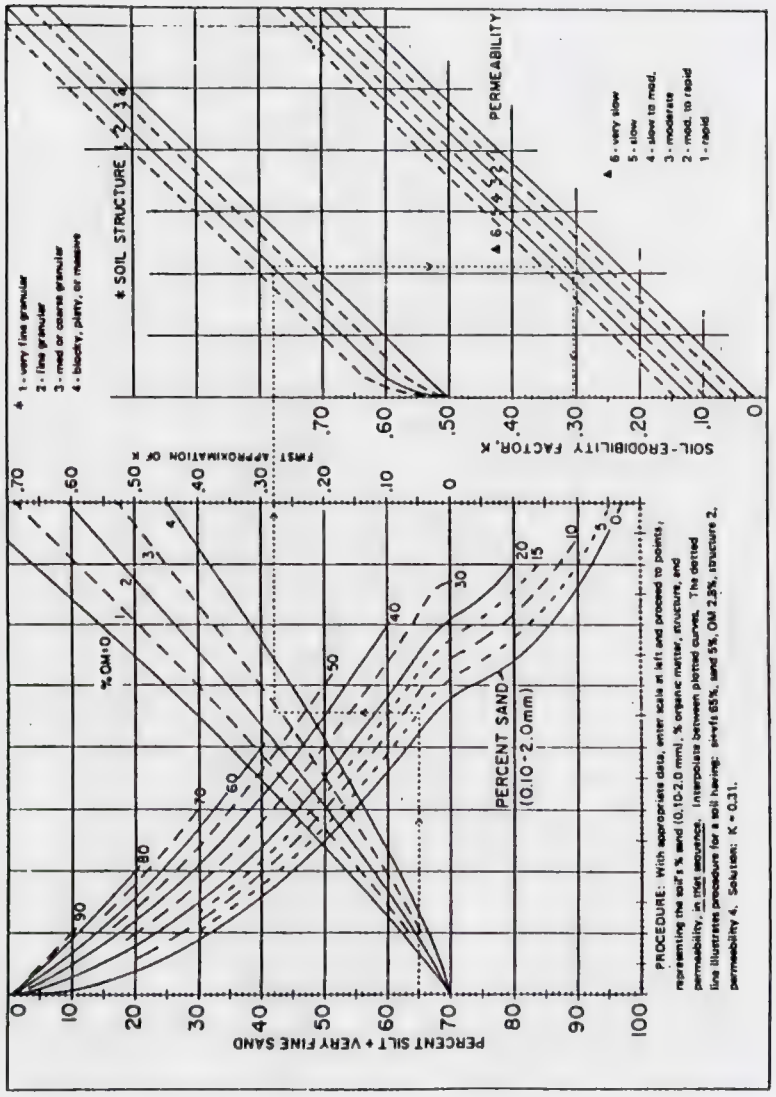


Figure 2.6. Nomograph for determining the soil-erodibility factor, K, for United States mainland soils (ARS, 1975)

ent soils erode at different rates when the other factors that affect erosion are the same. Soil properties that affect infiltration rate, permeability, total water capacity, dispersion, splash, abrasion, and transporting forces also affect erodibility. For a particular soil, the soil erodibility factor, K, is the rate of erosion per unit of erosion index from a standard plot.

Direct measurements of K were made for 23 major soils in the United States (Olson and Wischmeier, 1963; Wischmeier and Smith, 1965). Following these initial measurements, the K values for numerous other soils were approximated by considering the characteristics of the soil in comparison to measured soils. Additional direct measurements have been made at many locations world-wide.

Direct measurement of the K factor requires considerable time and equipment and is costly to perform. In an effort to eliminate this procedure, a study was conducted to describe the K factor using 15 soil properties and their interactions (Wischmeier and Mannering, 1969). A multiple-regression equation of 24 terms was developed and was considered valid for a broad range of medium textured

Table 2.2. Indications of the general magnitude of the soil-erodibility factor, K[a]

Texture class	Organic matter content		
	<0.5 per cent	2 per cent	4 per cent
	K	K	K
Sand	0.05	0.03	0.02
Find sand	0.16	0.14	0.10
Very fine sand	0.42	0.36	0.28
Loamy sand	0.12	0.10	0.08
Loamy fine sand	0.24	0.20	0.16
Loamy very fine sand	0.44	0.38	0.30
Sandy loam	0.27	0.24	0.19
Fine sandy loam	0.35	0.30	0.24
Very fine sandy loam	0.47	0.41	0.33
Loam	0.38	0.34	0.29
Silt loam	0.48	0.42	0.33
Silt	0.60	0.52	0.42
Sandy clay loam	0.27	0.25	0.21
Clay loam	0.28	0.25	0.21
Silty clay loam	0.37	0.32	0.26
Sandy clay	0.14	0.13	0.12
Silty clay	0.25	0.23	0.19
Clay		0.13–0.29	

[a] The values shown are estimated averages of broad ranges of specific-soil values. When a texture is near the borderline of two texture classes, use the average of the two K values. For specific soils, use of Figure 2.6 or Soil Conservation Service K-value tables will provide much greater accuracy. From ARS, 1975.

soils. However, it proved too cumbersome for general use. This deficiency, plus additional investigation, prompted the development of the soil erodibility nomograph, Figure 2.6 (Wischmeier *et al.*, 1971). The soil erodibility nomograph can be used to obtain the soil erodibility factor, K, for soils for which the K value has not previously been determined. It is particularly helpful for use in construction areas where the K values for subsoils are not known. Two important findings were made in the analysis leading to the development of this nomograph. The silt-size fraction was expanded to include the very fine sand classification and improved the prediction value of both sand and silt. The product of per cent silt and per cent sand-and-silt accounted for 85 per cent of the variance in observed K values for the soils analysed.

Five soil parameters are needed to use the nomograph: per cent silt (0.002–0.05 mm) plus very fine sand (0.05–0.10 mm), per cent sand (0.10–2.0 mm), organic matter content, structure, and permeability. Structure and permeability values are given in Figure 2.6. Additional guides for permeability described by Wischmeier *et al.* (1971), are: code fragipan soils as 6, code more permeable surface soils underlain by massive clay or silty clay as 5, code moderately permeable surface soils underlain by a silty clay or silty clay loam having a weak subangular or angular blocky structure as 4, and code as 3 if the subsoil structure grade is moderate or strong or the texture is coarser than silty clay loam.

If the measured soil erodibility value is available for a soil of interest it should be used as first choice in the USLE. The United States Soil Conservation Service has evaluated K for most soils in the United States. The soil erodibility nomograph is valuable for those soils where K values are not available from the sources mentioned above. Table 2.2 is available for a general estimation of K if the above data are not available.

2.2.3 The slope length factor, L, and the slope gradient factor, S

The effects of slope length and gradient are represented in the USLE as L and S, respectively; however, they are often evaluated as a single topographic factor, LS. Slope length is defined as the distance from the point of origin of overland flow to the point where the slope decreases sufficiently for deposition to occur or to the point where runoff enters a defined channel. The channel may be part of a drainage network or a constructed channel. Slope gradient is the field or segment slope, usually expressed as a percentage. The development of the USLE was based on a standard plot length of 22.13 metres (Wischmeier and Smith, 1965); therefore, the slope-length factor was defined as:

$$L = \left(\frac{x}{22.13}\right)^m \qquad (2.17)$$

where:

L = slope length factor,

x = slope length, metres, and
m = an exponent.

Current recommendations (Wischmeier and Smith, 1978) for the exponent m are:

$m = 0.5$ if slope ≥ 5 per cent,
$m = 0.4$ if slope < 5 per cent and > 3 per cent,
$m = 0.3$ if slope ≤ 3 per cent and ≥ 1 per cent, and
$m = 0.2$ if slope < 1 per cent.

These recommendations are reflected in the construction of the slope effect chart (Figure 2.7).

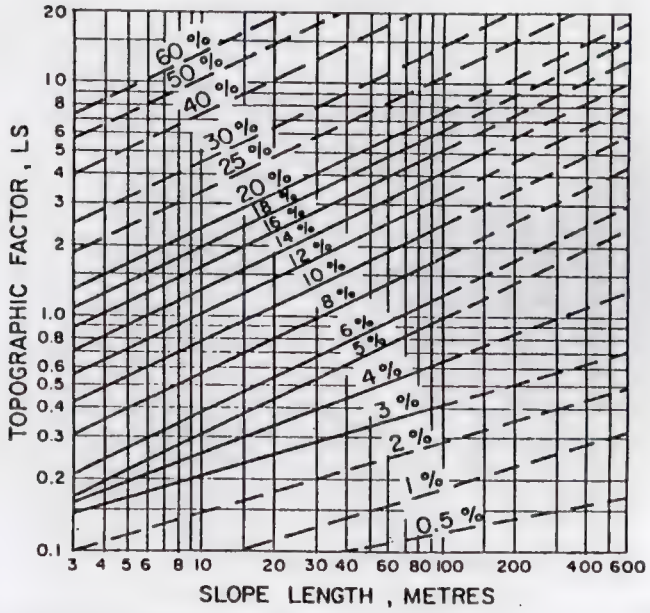


Figure 2.7. Slope length and gradient factor, LS, for use with the Universal Soil Loss Equation

Smith and Wischmeier (1957) also determined that soil loss was correlated with a parabolic description of the effect of slope steepness or gradient. Normalizing this equation to a standard plot slope of 9 per cent resulted in a description of the slope-gradient factor:

$$S = \frac{0.43 + 0.30s + 0.043s^2}{6.613} \qquad (2.18)$$

where:

S = the slope gradient factor, and
s = the gradient, per cent.

Equation (2.18) is recommended for the slope gradient factor and used in the development of the slope effect chart (Figure 2.7). Values of LS may be computed from:

$$LS = \left(\frac{x}{22.13}\right)^m (0.065 + 0.045s + 0.0065s^2) \qquad (2.19)$$

where all terms have been previously defined. Figure 2.7 is a convenient aid in obtaining the topographic factor, LS, for use in the USLE.

Equation (2.19) and Figure 2.7 were developed and should be used only for single uniform slopes. The use of the topographic factor, LS, described above, will usually overestimate soil loss from concave slopes and underestimate the loss from convex slopes. The first step in developing a method for computing soil loss for complex profiles was presented by Onstad *et al.* (1967) and continued by Foster and Wischmeier (1974) to provide a methodology for evaluating the effects of LS for irregular slopes. The irregular slope is divided into a series of n segments. Each slope segment should be uniform in gradient and soil type. The soil loss for the entire slope is then computed using:

$$A = (0.224)RKCP\left[\frac{\sum_{j=1}^{n} (S_j x_j^{m+1} - S_j x_{j-1}^{m+1})}{x_e (22.13)^m}\right] \qquad (2.20)$$

where:

x_j = the distance from the top of the slope to the lower end of the jth segment, metres,
x_{j-1} = is the slope length from the top of the slope to upper end of the jth segment, metres,
x_e = the overall slope length, metres,
S_j = the value of the slope-gradient factor for the j segment, and A, R, K, C, P, and m are as defined previously.

Wischmeier (1974) presented a simplified method for solving Equation (2.20) when the complex slope may be divided into two to five segments of equal length.

To illustrate the use of Equation (2.20), assume a convex slope of the following segments: 50 metres at 5 per cent slope, 40 metres at 8 per cent slope and 30 metres at 11 per cent slope. Table 2.3 is a result of the step by step solution of Equation (2.20). A tabular solution of Equation (2.20) is made more expedient by defining:

$$u_j = \frac{S_j x_j^{m+1}}{(22.13)^m} \quad \text{and} \quad u_{j-1} = \frac{S_j x_{j-1}^{m+1}}{(22.13)^m} \qquad (2.21)$$

Table 2.3. Determination of LS factor for a convex slope

Segment No.	Slope per cent	S_j	Length, metres	x_j	x_{j-1}	m	u_j	u_{j-1}	$u_j - u_{j-1}$	Segment LS	Percent of total soil loss
1	5	0.454	50	50	0	0.5	34	0	34	0.68	13
2	8	0.844	40	90	50	0.5	153	63	90	2.25	35
3	11	1.351	30	120	90	0.5	378	245	133	4.43	52
Sum			120						257	2.14	100
Entire slope											

The entire slope *LS* is obtained by dividing the sum of the $(u_j - u_{j-1})$ by x_e. The segment *LS* is obtained by dividing the $(u_j - u_{j-1})$ for that segment by the length of the segment. The last column of Table 2.3 shows the portion of the total soil loss that comes from each slope segment and is obtained by dividing the $(u_j - u_{j-1})$ for a segment by the sum of the $(u_j - u_{j-1})$. A concave slope of 120 metres total length and elevation difference of 9 metres can be examined by reversing the order of the slope segments of Table 2.3. The *LS* factor for this concave slope is 1.61 and the *LS* factor for a uniform 7.5 per cent slope of 120 metres length is 1.79.

It would be reasonable to expect that while progressing down a slope different soil types, hence, different K values would be found. This change may be incorporated into the procedure as follows:

$$A = (0.224)\frac{RCP}{x_e}\sum_{j=1}^{n} K_j\left[\frac{S_j x_j^{m+1} - S_j x_{j-1}^{m+1}}{(22.13)^m}\right] \qquad (2.22)$$

where:

K_j is the soil erodibility factor for the jth slope segment.

It is also reasonable to treat a change in the cropping management factor, C in a similar manner if land use changes on the slope.

2.2.4 The cropping management factor, *C*

The cropping management factor represents the ratio of soil loss from a specific cropping or cover condition to the soil loss from a tilled, continuous fallow condition for the same soil and slope and for the same rainfall. This factor includes the interrelated effects of cover, crop sequence, productivity level, growing season length, cultural practices, residue management, and rainfall distribution. The evaluation of the *C* factor is often difficult because of the many cropping and management systems. Crops can be grown continuously or rotated with other crops. Rotations are of various lengths and sequences. Residues can be removed or left on the field or incorporated into the soil. The soil may be clean tilled or one of several conservation tillage systems may be used. Each segment of the cropping and management sequence must be evaluated in combination with the rainfall erosivity distribution for the region.

Several effects of cropping and management were presented by Wischmeier (1960) and Wischmeier and Smith (1965) in the form of extensive tables of soil loss ratios. Greatly expanded tables of *C* factor values were presented by Wischmeier and Smith (1978) that represent most cropping and management schemes in use in the United States. A small portion of these recommendations are presented in Table 2.4. Six crop-stage periods are identified in Table 2.4

Table 2.4. Soil loss ratios for selected crops[a]

Cover, Sequence, and Management	Productivity kg/m²	Soil Loss Ratio, Percentage For Crop-Stage Period[b] F	SB	1	2	3	4
First-year corn after grain and legume hay, spring turn plough, conventional tillage, residue left	0.6+	8	22	19	17	10	14
Small grain in disked row-crop residue, after one year corn after meadow, residue left		—	12	12	11	7	2
Grass and legume meadow	0.7+						0.4

[a] From Wischmeier and Smith, 1978.
[b] Crop—stage periods:
F—Rough fallow
SB—Seedbed
1—Establishment
2—Development
3—Maturing Crop
4—Residue or stubble.

Table 2.5. Example of cropping-management (*C*) factor evaluation[a]

Crop Stage Period	Dates	Percent of Ann. Erosion Index[b]	Crop Stage Soil Loss, *C* Percentage	*C* Factor
Meadow	1/1–4/15	10	0.4	0.0004
Rough ploughed sod	4/15–5/5	5	8	0.0040
Disked and corn seedbed	5/5–6/1	10	22	0.0220
10–50 per cent canopy	6/1–6/20	13	19	0.0247
50–75 per cent canopy	6/20–7/10	14	17	0.0238
75 per cent canopy–harvest	7/10–10/15	40	10	0.0400
Residue	10/15–12/31	8	14	0.0112
	1/1–4/1	8	14	0.0112
Oat seedbed	4/1–4/15	2	12	0.0024
10–50 per cent canopy	4/15–5/1	4	12	0.0048
50–75 per cent canopy	5/1–6/1	11	11	0.0121
75 per cent–harvest	6/1–6/15	9	7	0.0063
New meadow in oat stubble	6/15–8/15	38	2	0.0076
Meadow (16.5 months)	8/15–1/1	128	0.4	0.0051
Total		300		0.1756
Average Annual *C* Factor				0.0585

[a] For assumed COM rotation in Central Corn belt, United States.
[b] From curve A, Figure 2.3.
[c] From Table 2.4.

Table 2.6. Generalized values of the cover and management factor, *C*, in the United States east of the 104° meridian[a]

Crop, rotation, and management[c]	Productivity level[b]	
	High	Mod.
	C value	
Base value: continuous fallow, tilled up and down slope	1.00	1.00
CORN		
C, Rdr, fall TP, conv(1)	0.54	0.62
C, RdR, spring TP, conv(1)	0.50	0.59
C, RdL, fall TP conv(1)	0.42	0.52
C, RdR, wc seeding, spring TP, conv(1)	0.40	0.49
C, RdL, standing, spring TP, conv(1)	0.38	0.48
C, fall shred stalks, spring TP, conv(1)	0.35	0.44
C(silage)–W(RdL, fall TP) (2)	0.31	0.35
C, RdL, fall chisel, spring disk, 40–30%rc(1)	0.24	0.30
C(silage), W wc seeding, no-till pl in c-k W(1)	0.20	0.24
C(RdL)–W(RdL, spring TP) (2)	0.20	0.28
C, fall shred stalks, chisel pl, 40–30%rc(1)	0.19	0.26
C-C-C-W-M,RdL, TP for C, disk for W(5)	0.17	0.23
C, RdL, strip till row zones, 55–40%rc(1)	0.16	0.24
C-C-C-W-M-M, RdL,TP for C, disk for W(6)	0.14	0.20
C-C-W-M, RdL, TP for C, disk for W(4)	0.12	0.17
C, fall shred, no-till pl, 70–50%rc(1)	0.11	0.18
C-C-W-M-M, RdL, TP for C, disk for W(5)	0.087	0.14
C-C-C-W-M, RdL, no-till pl 2d and 3rd C(5)	0.076	0.13
C-C-W-M, RdL, no-till pl 2d C(4)	0.068	0.11
C, no-till pl in c-k wheat, 90–70%rc(1)	0.062	0.14
C-C-C-W-M-M, no-till pl 2d and 3rd C(6)	0.061	0.11
C-W-M, RdL, TP for C, disk for W(3)	0.055	0.095
C-C-W-M-M, RdL, no-till pl 2d C(5)	0.051	0.094
C-W-M-M, RdL, TP for C, disk for W(4)	0.039	0.074
C-W-M-M-M, RdL, TP for C, disk for W(5)	0.032	0.061
C, no-till pl in c-k sod, 95–80%rc(1)	0.017	0.053
COTTON[d]		
Cot, conv(Western Plains) (1)	0.42	0.49
Cot, conv(South) (1)	0.34	0.40
MEADOW		
Grass and Legume mix	0.004	0.01
Alfalfa, lespedeza, or sericia	0.020	
Sweet clover	0.025	
SORGHUM, GRAIN (Western Plains)[d]		
RdL, spring TP, conv(1)	0.43	0.53
No-till pl in shredded 70–50%rc	0.11	0.18

Table 2.6. (*Continued*)

Crop, rotation, and management[c]	Productivity level[b]	
	High	Mod.
	C value	
SOYBEANS[d]		
B, RdL, spring TP, conv(1)	0.48	0.54
C-B, TP annually, conv(2)	0.43	0.51
B, no-till pl	0.22	0.28
C-B, no-till pl, fall shred C stalks (2)	0.18	0.22
WHEAT		
W-F, fall TP after W(2)	0.38	
W-F, stubble mulch, 0.06 kg rc(2)	0.32	
W-F, stubble mulch, 0.11 kg rc(2)	0.21	
Spring W, RdL, Sept TP, conv (N&S Dak) (1)	0.23	
Winter W, RdL, Aug TP, conv (Kans) (1)	0.19	
Spring W, stubble mulch, 0.08 kg rc(1)	0.15	
Spring W, stubble mulch, 0.14 kg rc(1)	0.12	
Winter W, stubble mulch, 0.08 kg rc(1)	0.11	
Winter W, stubble mulch, 0.14 kg rc(1)	0.10	
W-M, conv(2)	0.056	
W-M-M, conv(3)	0.026	
W-M-M-M, conv(4)	0.021	

[a] This table is for illustrative purposes only and is not a complete list of cropping systems or potential practices. Values of *C* differ with rainfall pattern and planting dates. These generalized values show approximately the relative erosion-reducing effectiveness of various crop systems, but locationally derived *C* values should be used for conservation planning at the field level. Tables of local values are available from the Soil Conservation Service. From ARS, 1975.

[b] High level is exemplified by long-term yield averages greater than 0.47 kg/m² corn or 0.7 kg/m² grass-and-legume hay; or cotton management that regularly provides good stands and growth.

[c] Numbers in parentheses indicate number of years in the rotation cycle. No. (1) designates a continuous one-crop system.

[d] Grain sorghum, soybeans, or cotton may be substituted for corn in rotation lines to estimate *C* values for sod-based rotations.

Abbreviations defined:

B—soybeans
C—corn
c-k—chemically killed
conv—conventional
cot—cotton
F—fallow
M—grass and legume hay
pl—plant
W—wheat
wc—winter cover
kg rc—kg of crop residue per m² remaining on surface after new crop seeding
%rc—percentage of soil surface covered by residue mulch after new crop seeding
70–50%rc—70% cover for *C* values in first column, 50% for second column
RdR—residues (corn stover, straw, etc.) removed or burned
RdL—all residues left on field (on surface or incorporated)
TP—turn plowed (upper 125 or more mm of soil inverted, covering residues).

and are defined as:

Period F—Rough fallow. Inversion ploughing to secondary tillage.
Period SB—Seedbed. Secondary tillage for seedbed to 10 per cent canopy cover.
Period 1—Establishment. 10–50 per cent canopy cover.
Period 2—Development. 50–75 per cent canopy cover.
Period 3—Maturing crop. 75 per cent canopy cover to crop harvest.
Period 4—Residue or stubble. Crop harvest to ploughing or new seeding.

The values in the body of Table 2.4 represent the soil loss expected for a specific condition during a specific crop-stage period as a percentage of the soil loss from continuous fallow. The crop stage tabular values were designed for use with erosion index distribution curves similar to Figure 2.3.

To derive a *C* value for a crop rotation, the year is divided into crop-stage periods as determined by the local ploughing, seeding, and harvest dates. The appropriate erosion index distribution curve is entered to obtain the percentage of annual erosion index expected within each crop stage period. The crop-stage *C* value multiplied by the corresponding value obtained from the distribution curve is the *C* value for that period. All the crop period *C* values are summed for the rotation and when divided by the number of years of the rotation the average annual *C* values for use in the USLE is obtained.

An example will serve to further explain the method for computing the average annual *C* factor. Assume a field in the central cornbelt of the United States (Region 16) that is in a 3 year rotation of corn–oats–grass and legume meadow. Corn yields are greater than 0.6 kg/m^2, meadow yields are 0.7–1.1 kg/m^2, and residues are left on the field. The crop stage dates are as listed in Table 2.5 which is a compilation of the method of evaluating the *C* factor for this situation. As a specific example consider the data for the corn seedbed period. From the erosion index distribution curve for Region 16 of Figure 2.3, 15 per cent and 25 per cent are obtained for May 5 and June 1, respectively. Thus, the portion of the annual erosion index for that period is 10 per cent. The soil loss ratio from Table 2.4 is 22 per cent for first year corn, after grass and legume hay, spring ploughed, conventional tillage, crop stage SB. The *C* factor for the corn seedbed crop period (0.022) is obtained by multiplying the percentage annual erosion index (0.10) by the crop stage soil loss ratio (0.22). The crop stage soil loss ratios for the other crop stages are determined in the same way and their sum (0.1756) divided by the number of years of the rotation (3) yields an annual average *C* factor of 0.0585 for this cropping management condition in the region. The effect of lower corn or meadow yields, of minimum tillage, or of different crop sequences in the rotation may be made by comparing *C* factor values.

This method of computation of local *C* values was not convenient for daily use by farm planners (Wischmeier, 1960). Therefore, it was recommended that

the table of crop stage soil loss ratios (excerpted in Table 2.4) be used to develop handbook values of average annual *C* factors for the common situations of specific areas. A compilation similar to Table 2.6 can be developed for such a purpose.

Table 2.6 is a list of generalized values of the *C* factor for the area east of the Rocky Mountains in the United States. It is for illustrative purposes and special notice should be taken of footnote 1 of the table. Cropping management factor evaluations can be obtained from local Soil Conservation Service handbooks for areas of specific interest in the United States.

Table 2.7. *C* values, percentage for undisturbed land[a]

Vegetal canopy		Mulch or vegetation at ground surface[b] Percentage cover					
Type and Height	Percentage Cover[c]	0	20	40	60	80	95–100
None		45	24	15	9.1	4.3	1.1
Tall weeds or short brush, 0.5 m effective height	25	36	20	13	8.3	4.1	1.1
	75	17	12	9	6.8	3.8	1.1
Brush or bushes, 2 m effective height	25	40	22	14	8.7	4.2	1.1
	75	28	17	12	7.8	4.0	1.1
Trees, 4 m effective height	25	42	23	14	8.9	4.2	1.1
	75	36	20	13	8.4	4.1	1.1
Factor to obtain *C* values with grass or compacted duff ground cover[d]		1.0	0.83	0.67	0.46	0.30	0.27

[a] From Wischmeier, 1974. (Reproduced by permission of SCSA).
[b] *C* values in Table are for ground cover of weeds or undecayed residue.
[c] For canopy cover between 25–75 per cent, straight line interpolation is appropriate.
[d] To obtain *C* values for ground cover of grass or compacted duff, multiply the *C* value from the table by the factor.

Table 2.7 lists *C* values that have been determined for permanent pasture, rangeland, and idle lands (Wischmeier, 1974). Smith and Ports (1976) have compiled recommended values of the *C* factor for construction areas treated with mulches and seeded, Table 2.8.

Elwell and Stocking (1976) presented a crop cover and classification approach for conditions tested in Rhodesia. The results of this approach included a relationship of soil loss as a function of the mean seasonal vegetal cover. Roose (1977) has developed average annual *C* factor values, (Table 2.9), for vegetal cover and cultural techniques for the area of West Africa described in Figure 2.5.

Table 2.8. *C* values for mulched and seeded areas[a]

Treatment	Mulch Rate, kg/m²	Slope, Percentage	*C* Value, Percentage[b] Period 1	Period 2
No mulch or seeding		all	100	—
Grain or fast growing grass:	none	all	70	10
Straw mulch[c]	0.22	⩽10	20	7
	0.34	⩽10	12	5
	0.45	⩽10	6	5
		11–15	7	5
		16–20	11	5
		21–25	14	5
		26–33	17	5
		34–50	20	5
Crushed stone	30.2	⩽15	5	5
	53.8	⩽20	2	2
Woodchips	1.6	⩽15	8	5
	2.7	⩽15	5	2
	5.6	⩽15	2	2
Permanent seeding,		all	—	1
second year		all	1	1

[a] From Smith and Ports, 1976 (Reproduced by permission of SCSA).
[b] Period 1: Through first six weeks of growing period; Period 2: after six weeks of growing period.
[c] Straw or hay mulch, tied down by anchoring and tracking equipment used on slope.

Table 2.9. The vegetal cover factor and cultural techniques (*C* factor) in West Africa[a]

Practice		Annual Average *C* Factor
Bare soil		1
Forest or dense shrub, high mulch crops		0.001
Savannah, prairie in good condition		0.01
Over-grazed savannah or prairie		0.1
Crop cover of slow development or late planting: 1st year		0.3 to 0.8
Crop cover of rapid development or early planting: 1st year		0.01 to 0.1
Crop cover of slow development or late planting: 2nd year		0.01 to 0.1
Corn, sorghum, millet (as a function of yield)		0.4 to 0.9
Rice (intensive fertilization)		0.1 to 0.2
Cotton, tobacco (2nd cycle)		0.5 to 0.7
Peanuts (as a function of yield and the date of planting)		0.4 to 0.8
1st year cassava and yam (as a function of the date of planting)		0.2 to 0.8
Palm tree, coffee, cocoa with crop cover		0.1 to 0.3
Pineapple on contour (as a function of slope)	burned residue	0.2 to 0.5
	buried residue	0.1 to 0.3
	surface residue	0.01
Pineapple and tie-ridging (slope 7 per cent)		0.1

[a] From Roose, 1977 (Reproduced by permission of ORSTOM and SCSA).

2.2.5 The erosion control practice factor, *P*

The erosion control practice factor is the ratio of soil loss using the specific practice compared with the soil loss using up-and-down hill culture. The erosion control practices usually included in this factor are contouring, contour strip-cropping, and terracing. Conservation tillage, crop rotations, fertility treatments, and the retention of residues are important erosion control practices. However, these cultural practices are included in the cropping management factors described earlier.

Table 2.10. Erosion control practice factor, *P*[a]

Land Slope, percentage	Contouring	Contour Strip cropping and Irrigated Furrows	Terracing[b]
1–2	0.60	0.30	0.12
3–8	0.50	0.25	0.10
9–12	0.60	0.30	0.12
13–16	0.70	0.35	0.14
17–20	0.80	0.40	0.16
21–25	0.90	0.45	0.18

[a] From Wischmeier and Smith, 1978.
[b] For prediction of contribution to off-field sediment load.

The practice factors for the three major mechanical practices as recommended by Wischmeier and Smith (1978) are shown in Table 2.10. Within a practice type the *P* factor is most effective for the 3–8 per cent slope range and values increase as the slope increases. As slope decreases below 2 per cent the practice factor value increases due to the reduced effect of the practice when compared with up-and-down-hill cultivation. The factor for terracing in Table 2.10 is for the prediction of the total off-the-field soil loss. If within-terrace interval soil loss is desired, the terrace interval distance should be used for the slope length factor, *L*, and the contouring *P* value used for the practice factor.

2.2.6 Soil loss tolerance

Soil loss tolerance is the maximum rate of soil erosion that permits a high level of productivity to be sustained. Tolerances for specific soils in the United States have been the subject of several workshops where soil scientists have collectively evaluated the soils and then recommended tolerance values. In general, deep, medium textured, moderately permeable soils that have sub-soil characteristics favourable for plant growth were assigned tolerances of 1.1 kg/m²/year. Soils with a shallow root zone or other detrimental characteristics were assigned lower tolerances. Recommended soil loss tolerance values for

APPENDIX F-3

Runon Ditches, Runoff Ditches, and Sediment Basins Sizing

TECHNOLOGIES INC BY AES DATE 12/15/98

JOB TITLE SST - MWRR-2 JOB NUMBER 98S3493.110

SUBJECT Run-on Ditch Design SHEET 1 of 14

Intensity - Duration Curve Development

Reference: NOAA Atlas 2 for Montana

100-yr 6 hr rain depth = 1.6 in. (X_1)

100-yr 24 hr rain depth = 2.7 in. (X_2)

elevation in hundreds of feet = 53 (X_3)

$$\text{100-yr 1 hr depth} = 0.338 + 0.670\left[X_1\left(\frac{X_1}{X_2}\right)\right] + 0.001\,X_3$$

$$= 0.338 + 0.670\left[1.6\left(\frac{1.6}{2.7}\right)\right] + 0.001(53)$$

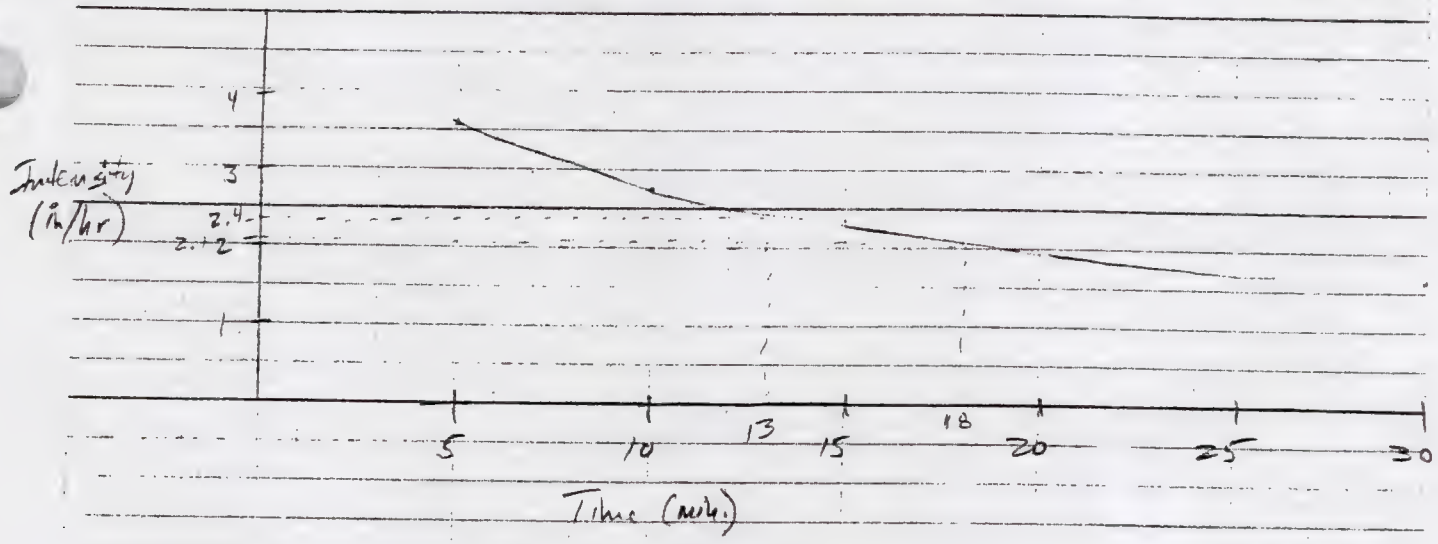
$$= 1.03 \text{ inches}$$

depth at 30 min. duration = 1.03 in (0.79) = 0.81 in.; $I = \frac{0.81 \text{ in}}{30 \text{ min}}\left(\frac{60 \text{ min}}{1 \text{ hr}}\right) = 1.62$ in/hr

depth at 15 min. duration = 1.03 in (0.57) = 0.59 in.; $I = \frac{0.59 \text{ in}}{15 \text{ min}}\left(\frac{60 \text{ min}}{1 \text{ hr}}\right) = 2.36$ in/hr

depth at 10 min. duration = 1.03 in (0.45) = 0.46 in.; $I = \frac{0.46 \text{ in}}{10 \text{ min}}\left(\frac{60 \text{ min}}{1 \text{ hr}}\right) = 2.76$ in/hr

depth at 5 min. duration = 1.03 in (0.29) = 0.30 in.; $I = \frac{0.30 \text{ in}}{5 \text{ min}}\left(\frac{60 \text{ min}}{1 \text{ hr}}\right) = 3.60$ in/hr



Overland Travel Time & Intensity

West

Travel distance = 600 ft (measured)
% slope = $\frac{5570-5480}{600}(100) = 15\%$ (measured)
C = 0.3 (assumed)

Overland Travel Time (min.) = 18 min.

East

Travel distance = 290' (measured)
% slope = $\frac{5530-5490}{290'}(100) = 13.8\%$ (measured)

C = 0.3 (assumed)

Overland Travel Time (min.) = 13 min

Intensity (Travel time corrected)

West

100 yr 1 hr depth multi. factor = $0.79 - \left[\frac{(0.79-0.57)}{30-15}\right]12$

$= 0.614$

$\text{Intensity}_{18\text{ min.}} = \frac{1.03\text{ in}\,(0.61)}{18\text{ min}\left(\frac{1\text{ hr}}{60\text{ min}}\right)}$

$= 2.09\text{ in/hr}$

East

100 yr 1 hr depth multi. factor = $0.57 - \left[\frac{(0.57-0.45)}{15-10}\right]2$

$= 0.52$

$\text{Intensity}_{13\text{ min}} = \frac{1.03\text{ in}\,(0.52)}{13\text{ min}\left(\frac{1\text{ hr}}{60\text{ min}}\right)}$

$= 2.47\text{ in/hr}$

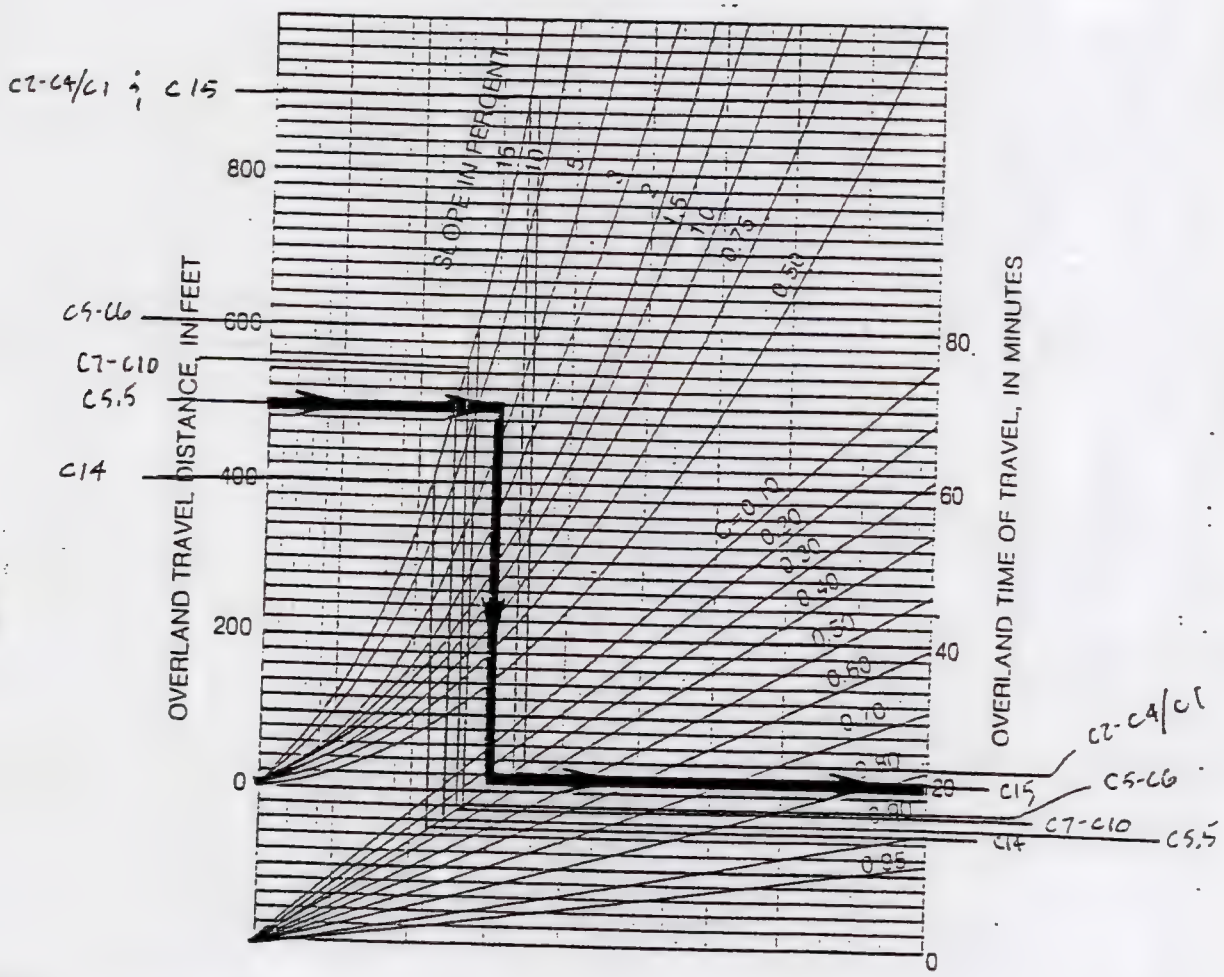


Figure 2
Relation of overland time of travel to overland travel distance, average overland slope, and coefficient C —for use in Rational Method.

Source:
Wright-McLaughlin Engineers/
"Airport Drainage,"
Federal Aviation Administration
Washington, DC 1965.

Peak Flow Estimates

$Q_i = C i A$

West

$C = 0.30$ (assumed)
$i = 2.09$ in/hr
$A = 9.07$ ac

$Q_{100} = 0.3(2.09 \text{ in/hr})(9.07 \text{ ac})$

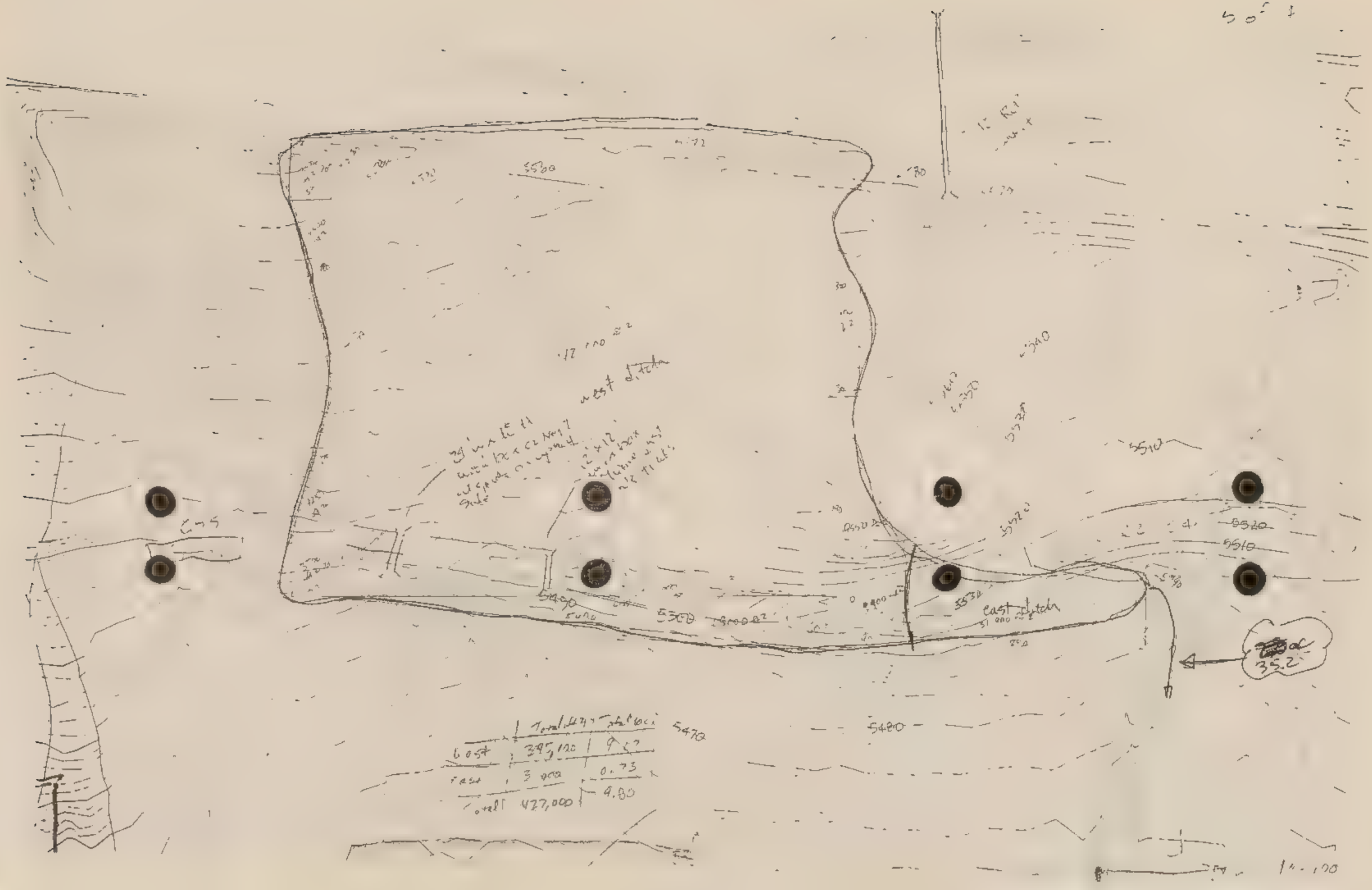
$= 5.7$ cfs

East

$C = 0.30$ (assumed)
$i = 2.47$ in/hr
$A = 0.73$ ac

$Q_{100} = 0.3(2.47 \text{ in/hr})(0.73 \text{ ac})$

$= 0.54$ cfs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west ditch
east ditch
Cost
Total
427,000
4.80
0.73
3,000
395,120
9.52
35.2
14.100

Topsoil Stockpile (2,600 cy)

Topsoil Stockpile (4,530 cy)

Relocate Drainage Between Arrows

Relocate Power Line

Install Culverts Beneath Highway at Locations Shown

Construction Sediment Pond

Protect Existing Utilities From Damage

Construct Haul Route

Haul Road

Burlington Northern Railroad

MAXIM TECHNOLOGIES INC

JOB TITLE Site 2 AUBAR 2 JOB NUMBER

SUBJECT Klua on Ditch Design - Profile

BY AES

DATE 10/6/93

SHEET 1 of 14

NUMBER

SHEET

DATE

Existing Ground

Design Ditch Profile

MAXIM TECHNOLOGIES INC

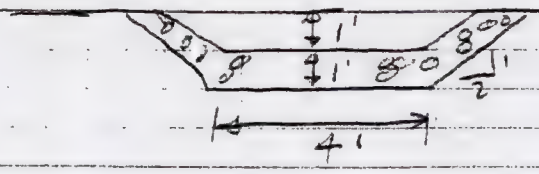
BY G. FISCHER DATE 12/30/93

JOB TITLE SST - MWRRT Runon Ditch JOB NUMBER 995349Z-110

SUBJECT Runon Ditch Design SHEET 8 of 14

RIPRAP Design

The attached model printouts for RIPRAP software indicates that a channel cross section with a 4' bottom and 2:1 side slopes would be adequate for a maximum 5.7 cfs flows with channel slopes ranging from 1% to 20%. The calculated D_{50} for the riprap from various methods ranges from .04 ft to 0.62 ft. This matches well with Type II stone which has D_{40}-D_{60} of 7 inches, or 0.6 ft. The RIPRAP program assigns a minimum gradation with 1.43 ft thickness and D_{100} of 1.3 ft. This is conservative for our design. A 12-inch thick blanket of Type II stone appears adequate with a D_{100} of 10 inches (0.83 ft).



WEST Consultants, Inc.
2111 Palomar Airport Rd.
Suite 180
Carlsbad, CA 92009-1419

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	5.7	
Bottom Width, ft	4.00	
Left Channel Side Slope	2.0	H:1V
Right Channel Side Slope	2.0	H:1V
Bottom Manning's "n"	0.0400	
Left Manning's "n"	0.0400	
Right Manning's "n"	0.0400	
Channel Longitudinal Slope	0.20000	

USCOE Method

Input Parameters:

Run Name: MWRRDTCH Description: RUNON DITCH FOR MWRR 2

Velocity	Average
Channel Type	Trapezoidal
Straight Channel	Yes
Bend Angle, °	N/A
Average Channel Velocity, ft/sec	5.41
Bottom Width, ft	N/A
Minimum Centerline Bend Radius, ft	N/A
Water Surface Width, ft	N/A
Unit Weight of Stone, lbs/cu ft	135.00
Riprap Layer Thickness	1.00
Local Flow Depth, ft	0.24
Cotangent of Sideslope	2.00
Safety Factor	1.10

Output Results:

Computed Local Depth Average Velocity, ft/sec	5.41
Local Velocity / Avg. Channel Velocity	1.00
Correction for Layer Thickness	1.00
Side Slope Correction Factor	1.18
Correction for Secondary Currents	1.00

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.41
Specific Weight, pcf	135.00
Layer Thickness, ft	1.00
Selected Minimum D30, ft	0.49
Selected Minimum D90, ft	0.71

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum

W100	28	71
W50	14	21
W15	4	10

GRF

USBR Method

Input Parameters:

Run Name: MWRRDTCH Description: RUNON DITCH FOR MWRR 2

Average Channel Velocity, ft/sec 5.41

Output Results:

Computed D50, ft 0.40

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

USGS Method

Input Parameters:

Run Name: MWRRDTCH Description: RUNON DITCH FOR MWRR 2

Average Channel Velocity, ft/sec 5.41

Output Results:

Computed D50, ft 0.62

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

Isbash Method

Input Parameters:

Run Name: MWRRDTCH Description: RUNON DITCH FOR MWRR 2

Average Channel Velocity, ft/sec 5.41
Unit Weight of Stone, lbs/cu ft 135.00
Turbulence Level Low

Output Results:

Computed D50, ft 0.27

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

WEST Consultants, Inc.
2111 Palomar Airport Rd.
Suite 180
Carlsbad, CA 92009-1419

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	5.7	
Bottom Width, ft	4.00	
Left Channel Side Slope	2.0	H:1V
Right Channel Side Slope	2.0	H:1V
Bottom Manning's "n"	0.0400	
Left Manning's "n"	0.0400	
Right Manning's "n"	0.0400	
Channel Longitudinal Slope	0.01000	

USCOE Method

Input Parameters:

Run Name: MWRRDTCH Description: RUNON DITCH FOR MWRR 2

Velocity	Average
Channel Type	Trapezoidal
Straight Channel	Yes
Bend Angle, °	N/A
Average Channel Velocity, ft/sec	2.06
Bottom Width, ft	N/A
Minimum Centerline Bend Radius, ft	N/A
Water Surface Width, ft	N/A
Unit Weight of Stone, lbs/cu ft	135.00
Riprap Layer Thickness	1.00
Local Flow Depth, ft	0.54
Cotangent of Sideslope	2.00
Safety Factor	1.10

Output Results:

Computed Local Depth Average Velocity, ft/sec	2.06
Local Velocity / Avg. Channel Velocity	1.00
Correction for Layer Thickness	1.00
Side Slope Correction Factor	1.18
Correction for Secondary Currents	1.00

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.03
Specific Weight, pcf	135.00
Layer Thickness, ft	0.75
Selected Minimum D30, ft	0.37
Selected Minimum D90, ft	0.53

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum

W50	6	9
W15	2	4

GRF

USBR Method

Input Parameters:

Run Name: MWRRDTCH Description: RUNON DITCH FOR MWRR 2

Average Channel Velocity, ft/sec 2.06

Output Results:

Computed D50, ft 0.05

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

USGS Method

Input Parameters:

Run Name: MWRRDTCH Description: RUNON DITCH FOR MWRR 2

Average Channel Velocity, ft/sec 2.06

Output Results:

Computed D50, ft 0.06

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

Isbash Method

Input Parameters:

Run Name: MWRRDTCH Description: RUNON DITCH FOR MWRR 2

Average Channel Velocity, ft/sec 2.06
Unit Weight of Stone, lbs/cu ft 135.00
Turbulence Level Low

Output Results:

Computed D50, ft 0.04

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

MAXIM TECHNOLOGIES INC

BY AFS DATE 12/16/99

JOB TITLE SST MWRR-2 JOB NUMBER 98-53495.110

SUBJECT Relocated Drainage Design SHEET 1 of 7

Total Travel Time = 28 min. [from G. Fischer calcs. dated 1/16/98]

Intensity

100 yr / 1 hr depth mult. factor = $0.79 - \left[\frac{(0.79-0.5)}{30-15}\right]2$

$= 0.761$

$\text{Intensity}_{25\text{ min.}} = \frac{1.03 \text{ in } (0.761)}{28 \text{ min } \left(\frac{1 \text{ hr}}{60 \text{ min}}\right)}$

$= 1.68 \text{ in/hr}$

Peak Flow Estimate =

$Q_p = CiA$

$C = 0.3$ (assumed)

$i = 1.68$ in/hr

$A = 35.2$ ac [from G. Fischer calcs. dated 1/16/98]

$Q_{100} = 0.3\,(1.68 \text{ in/hr})(35.2 \text{ ac})$

$= 17.7$ cfs

Section E Slope calc. $Q_p = 17.7$ cfs

horiz. length = 265 ft

vertical = 5470 ft − 5450 ft = 20 ft

% slope = $\frac{20 \text{ ft}}{270 \text{ ft}}(100) = 7.4\%$ [0.074 ft/ft]

GRF 1/4/99

Section E Design Example:

Mannings Coeff. = 0.04 (Riprap)

Channel slope = 0.074 ft/ft, measured

Depth = 0.26 ft

left side slope = 2:1, assumed

right side slope = 2:1, assumed

bottom width = 8 ft, assumed

discharge = 17.7 cfs, calculated above

MAXIM TECHNOLOGIES INC

BY G Fischer DATE 12/30/98

JOB TITLE SST-MUÑEZ Relocated Ditch JOB NUMBER

SUBJECT Relocated Channel Design SHEET 1 of 7

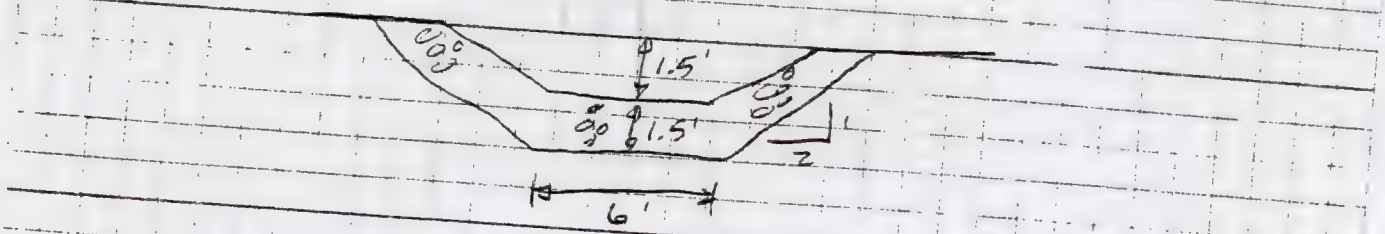
RELOCATED CHANNEL

$Q_{100} = 17.7$ cfs

$S_{max} = 0.10$ ft/ft or 10% (measured from drawing)

$S_{min} = 0.01$ ft/ft or 1% (assumed)

From the attached RIPRAP software printout, a channel with a 6 ft bottom and 2:1 side slopes gives flow depths ranging from 0.43 to 0.84 ft. D_{50} rock sizes range from 0.07 to 0.77 ft, which is still conducive for Type ~~I~~ II stone, however it is recommended that the blanket thickness is 1.5 ft.



WEST Consultants, Inc.
2111 Palomar Airport Rd.
Suite 180
Carlsbad, CA 92009-1419

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	17.7	
Bottom Width, ft	6.00	
Left Channel Side Slope	2.0	H:1V
Right Channel Side Slope	2.0	H:1V
Bottom Manning's "n"	0.0400	
Left Manning's "n"	0.0400	
Right Manning's "n"	0.0400	
Channel Longitudinal Slope	0.01000	

USCOE Method

Input Parameters:

Run Name: MWRRCHNL Description: RELOCATED EAST CHANNEL - MWRR2

Velocity	Average
Channel Type	Trapezoidal
Straight Channel	Yes
Bend Angle, °	N/A
Average Channel Velocity, ft/sec	2.76
Bottom Width, ft	N/A
Minimum Centerline Bend Radius, ft	N/A
Water Surface Width, ft	N/A
Unit Weight of Stone, lbs/cu ft	135.00
Riprap Layer Thickness	1.00
Local Flow Depth, ft	0.84
Cotangent of Sideslope	2.00
Safety Factor	1.10

Output Results:

Computed Local Depth Average Velocity, ft/sec	2.76
Local Velocity / Avg. Channel Velocity	1.00
Correction for Layer Thickness	1.00
Side Slope Correction Factor	1.18
Correction for Secondary Currents	1.00

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.06
Specific Weight, pcf	135.00
Layer Thickness, ft	0.75
Selected Minimum D30, ft	0.37
Selected Minimum D90, ft	0.53

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum

W100	12	30
W50	6	9
W15	2	4

3 of 7
CRF

USBR Method

Input Parameters:

Run Name: MWRRCHNL Description: RELOCATED EAST CHANNEL - MWRR2

Average Channel Velocity, ft/sec 2.76

Output Results:

Computed D50, ft 0.10

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

USGS Method

Input Parameters:

Run Name: MWRRCHNL Description: RELOCATED EAST CHANNEL - MWRR2

Average Channel Velocity, ft/sec 2.76

Output Results:

Computed D50, ft 0.12

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

Isbash Method

Input Parameters:

Run Name: MWRRCHNL Description: RELOCATED EAST CHANNEL - MWRR2

Average Channel Velocity, ft/sec 2.76
Unit Weight of Stone, lbs/cu ft 135.00
Turbulence Level Low

Output Results:

Computed D50, ft 0.07

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

WEST Consultants, Inc.
2111 Palomar Airport Rd.
Suite 180
Carlsbad, CA 92009-1419

PROGRAM OUTPUT

*** The following input parameters were used to calculate ***
Average Velocity and Maximum Flow Depth for this Run.

Discharge, ft/sec	17.7	
Bottom Width, ft	6.00	
Left Channel Side Slope	2.0	H:1V
Right Channel Side Slope	2.0	H:1V
Bottom Manning's "n"	0.0400	
Left Manning's "n"	0.0400	
Right Manning's "n"	0.0400	
Channel Longitudinal Slope	0.10000	

USCOE Method

Input Parameters:

Run Name: MWRRCHNL Description: RELOCATED EAST CHANNEL - MWRR2

Velocity	Average
Channel Type	Trapezoidal
Straight Channel	Yes
Bend Angle, °	N/A
Average Channel Velocity, ft/sec	5.94
Bottom Width, ft	N/A
Minimum Centerline Bend Radius, ft	N/A
Water Surface Width, ft	N/A
Unit Weight of Stone, lbs/cu ft	135.00
Riprap Layer Thickness	1.00
Local Flow Depth, ft	0.43
Cotangent of Sideslope	2.00
Safety Factor	1.10

Output Results:

Computed Local Depth Average Velocity, ft/sec	5.94
Local Velocity / Avg. Channel Velocity	1.00
Correction for Layer Thickness	1.00
Side Slope Correction Factor	1.18
Correction for Secondary Currents	1.00

*** Using Gradation from COE ETL 1110-2-120 ***

Computed D30, ft	0.45
Specific Weight, pcf	135.00
Layer Thickness, ft	1.00
Selected Minimum D30, ft	0.49
Selected Minimum D90, ft	0.71

Percent Lighter by Weight	Stone Weight, lbs Minimum	Maximum

W50	14	21
W15	4	10

6 of 7
GRF

USBR Method

Input Parameters:

Run Name: MWRRCHNL Description: RELOCATED EAST CHANNEL - MWRR2

Average Channel Velocity, ft/sec 5.94

Output Results:

Computed D50, ft 0.48

7 of 7
GRF

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

USGS Method

Input Parameters:

Run Name: MWRRCHNL Description: RELOCATED EAST CHANNEL - MWRR2

Average Channel Velocity, ft/sec 5.94

Output Results:

Computed D50, ft 0.77

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

Isbash Method

Input Parameters:

Run Name: MWRRCHNL Description: RELOCATED EAST CHANNEL - MWRR2

Average Channel Velocity, ft/sec 5.94
Unit Weight of Stone, lbs/cu ft 135.00
Turbulence Level Low

Output Results:

Computed D50, ft 0.33

*** Using FHWA Gradation ***

Gradation Class Facing
Layer Thickness, ft 1.43

Percent Smaller by Size	Rock Size, ft	Rock Size, lbs
D100	1.30	200
D50	0.95	75
D10	0.40	5

MAXIM TECHNOLOGIES INC

BY G. FISCHER DATE 12/29/98

JOB TITLE CST - MWRR2 Rumon Ditch JOB NUMBER 9853493-110

SUBJECT Cost Analysis SHEET 1 of 4

COST FOR EROSION MAT - INSTALLED

MATERIAL — North American Green C350

- $150/roll, 40 sy/roll, roll is 6.5' wide

(Roscoe Steel, Billings, Clyde Bennett 406-656-2253)

- for proposed ditch, need 2 rolls for width

- cost per linear ft:

roll is 55.4 ft long

for 55.4 linear ft 2 rolls = $300

cost = $5.42 / lf

DITCH — Length ≅ 1280 ft (includes anchor trench length)

# of rolls = $\frac{1280(2)}{55.4}$ = 47 rolls, or 1880 sy

TOTAL MATERIAL COST = 5.42(1280) = $6937.60

say $6950.00

LABOR — from Clyde Bennett, rule of thumb is (after excav)

1000 sy / 5 mh assume $40/mh

∴ $200/1000 sy or $0.2/sy

for 1880 sy, Labor = $0.2(1880) = $376, low!

To include trenching and other misc → say $3000

MAXIM TECHNOLOGIES INC

BY G. FISCHER DATE 12/29/98

JOB TITLE SST- MWRR2 Rumon Ditch JOB NUMBER

SUBJECT Costs SHEET 3 of 4

COST FOR RIPRAP - INSTALLED

MATERIAL - Delivered to site - $8.40/cy

(Tim Reilly, DEQ)

Installation - assume ~ $4.00/cy

Total - $12.40/cy

Material per linear ft = 1.0 x (4+5) x 1 = 9.0 cf

= 0.3 cy/lf

Total material = 0.3 cy/lf x 1280 lf = 427 cy

Total cost installed = 427 (12.40) = $5295

Additional excavation compared to erosion mat:

$\frac{1.0 \times 15 \times 1280}{27}$ = 711 cy @ $1.50/cy

= $1067

Filter Fabric - estimate 18' width x 1280' length

= 23040 sf

@ $0.20/sf installed = $4608

Total Cost = $10,970

* Advantage is that riprap will not have to be revegetated.

MAXIM TECHNOLOGIES INC

BY G. Fischer DATE 12/29/98

JOB TITLE MWRRT Runoff Ditch JOB NUMBER

SUBJECT Costs SHEET 4 of 4

CONCLUSION

USE RIPRAP-LINED CHANNEL

BECAUSE :

- COST IS LESS THAN EROSION MAT.
- NO REVEG REQUIRED
- COMMON CONSTRUCTION MATERIAL FOR THIS JOB.
- NO LOGISTICAL PROBLEMS WITH REVEG.

****

NORTH AMERICAN GREEN CHANNEL PROTECTION
USER SPECIFIED CHANNEL LINING ANALYSIS

****

PROJECT NAME:
COMPUTED BY: GARY FISCHER
FROM STATION/REACH:
DRAINAGE AREA:

PROJECT NO.: 9853493-110
DATE: 12-29-1998
TO STATION/REACH:
DESIGN FREQUENCY: 100

Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)
4.00	2.0	2.0	0.200

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (ft/sec)	Area (sf)	Hydraulic Radius (ft)	Normal Depth (ft)
0.5	4.0	2.37	0.23	0.05	0.06

Lining Type	Manning Coefficient	Permissible Shear (lb/sf)	Calculated Shear (lb/sf)	Safety Factor	Remark
C350 Staple E Phase 1 (Unvegetated)	0.040	2.25	0.69	3.25	STABLE

****

NORTH AMERICAN GREEN CHANNEL PROTECTION
USER SPECIFIED CHANNEL LINING BACK-UP COMPUTATIONS

****

PROJECT NAME:

PROJECT NO.: 9853493-110

COMPUTED BY: GARY FISCHER
FROM STATION/REACH:
DRAINAGE AREA:

DATE: 12-29-1998
TO STATION/REACH:
DESIGN FREQUENCY: 100

****
INPUT PARAMETERS
****

Channel Discharge	:	0.5 cfs
Peak Flow Period	:	4.0 hours
Channel Slope	:	0.200 (ft/ft)
Channel Bottom Width	:	4.00 ft
Left Side Slope	:	2.0:1
Right Side Slope	:	2.0:1

Channel Lining Type : C350 Staple E Permissible Shear(Tp) : 2.25 psf
Phase = 1

****
CALCULATIONS
****

Intial Depth Estimate = 0.16 * (0.5 /(0.200^0.5))^0.375	=	0.17 ft
Final Channel Depth (after 9 iterations)	=	0.06 ft
Flow Area = (4.00 * 0.06) + (0.5 * 0.06^2 * (2.0 + 2.0))	=	0.23 ft^2
Wet Perim. = 4.00+(0.06*(((2.0^2)+1)^.5 +((2.0^2) + 1)^.5))	=	4.25 ft
Hydraulic Radius = (0.23 / 4.25)	=	0.05 ft
Channel Velocity = (1.486 / 0.040) * (0.05^0.667) * (0.200^.5)	=	2.37 fps
Channel Effective Manning's Roughness	=	0.0400
Calculated Shear (Td) = 62.4 * 0.06 * 0.200	=	0.69 ps
Safety Factor = (Tp/Td) = (2.25 / 0.69)	=	3.25

****
NORTH AMERICAN GREEN CHANNEL PROTECTION
MATERIAL SPECIFICATIONS
****

C350 Specification

North American Green C350 permanent erosion control/turf reinforcement mat is constructed of 100% coconut fiber stitch bonded between a heavy duty UV stabilized bottom net, and a heavy duty UV stabilized cuspated (crimped) middle netting overlaid with a heavy duty UV stabilized top net. The cuspated netting forms prominent closely spaced ridges across the entire width of the mat. The three nettings are stitched together on 1.5" centers with UV stabilized polyester thread to form a permanent three dimensional structure. The following list contains further physical properties of the C350

Erosion Control/Turf Reinforcement Mat.

Property	Test Method	Value	Unit
Ground Cover	Image Analysis	93	%
Thickness	ASTM D1777	.63	in
Mass Per Unit Area	ASTM D3776	.92	lb/sy
Tensile Strength	ASTM D5035	480	lb/ft
Elongation	ASTM D5035	49	%
Tensile Strength	ASTM D5035	960	lb/ft
Elongation	ASTM D5035	31	%
Tensile Strength	ASTM D1682	177	lbs
Elongation	ASTM D1682	22	%
Resiliency	ASTM D1777	>80	%
UV Stability*	ASTM D4355	151	lbs
		86	%
Color(permanent net)		UV Black	
Porosity(permanent net)	Calculated	>95	%
Minimum Filament Diameter (permanent net)	Measured	.03	in

*ASTM D1682 Tensile Strength and % Strength Retention of material after 1000 hours of exposure in Xenon-Arc Weatherometer

MAXIM TECHNOLOGIES INC

BY G Fischer DATE 12/31/98

JOB TITLE CST - MWRR Sediment Ponds JOB NUMBER

SUBJECT Sed Pond Design SHEET 1 of 4

MWRR SEDIMENT PONDS

Criteria :
1. Meet MDEQ Sediment Control requirements.
2. Be in place for at least one year.
3. For construction and post-construction during vegetation establishment.
4. Two Ponds : 1. East pond for 3 acre drainage
   2. West pond for 6 acre drainage.
5. Rational Method for runoff.
6. Inflow design is the 10-yr, 24-hr storm peak discharge.

Reference : Montana Sediment and Erosion Control Manual, MDEQ, Revised May 1996.

Runoff Travel Time

Slope for MWRR is 1:4 or 25%.

Overland travel distance is 500 ft.

C coefficient = 0.3.

From Fig 2 on sht 2, overland travel time is 12 minutes.

Rainfall Intensity :

From Fischer calcs dated 1/5/98 for other sediment ponds :

$I_{12min} \cong 0.30$ in/hr for the 10-yr storm.

MAXIM TECHNOLOGIES INC

BY G. FISCHER DATE 12/29/98

JOB TITLE MWRRC Runon Ditch JOB NUMBER

SUBJECT Costs SHEET 2 of 4

EROSION MAT (cont'd)

Revegetation - replace topsoil ~ 240 cy

@ $2.00/cy = $480

Reveg - assume ~ $1000

$1480

Total costs = $11,430.

* Disadvantage is that reveg likely will not occur until the spring following construction, leaving the ditch unprotected during the runoff season.

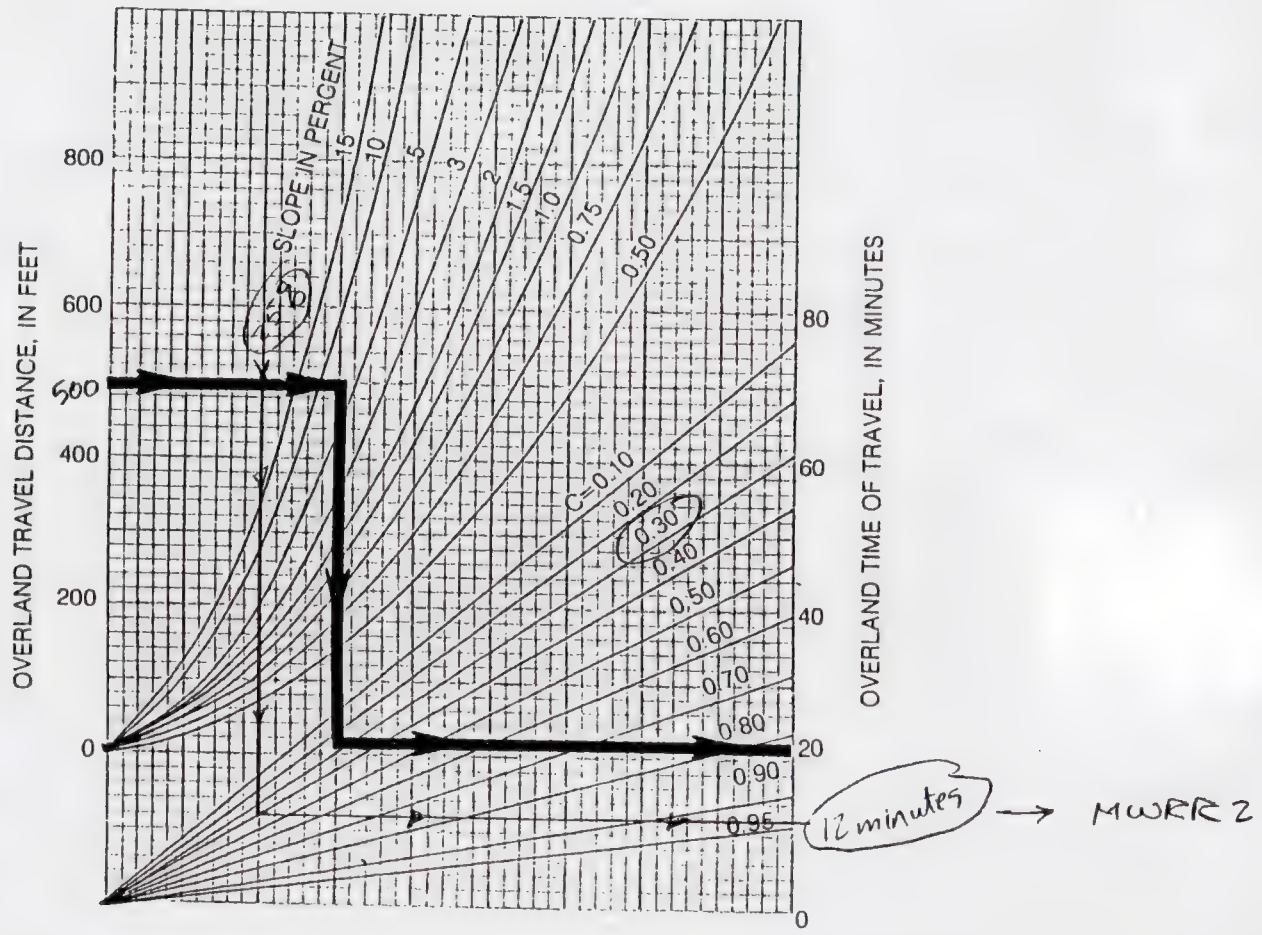


Figure 2
Relation of overland time of travel to overland travel distance, average overland slope, and coefficient C —for use in Rational Method.

Source:
Wright-McLaughlin Engineers/
"Airport Drainage,"
Federal Aviation Administration
Washington, DC 1965.

Sht 2 of 4
GRF

MAXIM TECHNOLOGIES INC

BY G Fischer DATE 12/31/98

JOB TITLE SST-MWRR JOB NUMBER

SUBJECT Sed Ponds SHEET 3 of 4

Peak Flows: $Q_{peak} = CIA$

East $Q_{peak} = 0.3(0.30)(3) = 0.3$ cfs

West $Q_{peak} = 0.3(0.3)(6) = 0.6$ cfs

Pond Surface Area:

$$SA = \frac{1.2\,Q_{10}}{V_{bod}}$$

$V_{bod} = 0.00096$ fps for a 20 µm particle.

$$SA_{east} = \frac{1.2(0.3)}{0.00096} = 375 \text{ sf}$$

$$SA_{west} = \frac{1.2(0.6)}{0.00096} = 750 \text{ sf}$$

MAXIM TECHNOLOGIES INC

BY G. FISCHER DATE 1/4/99

JOB TITLE SST - MWRR2 JOB NUMBER

SUBJECT Runoff Ditches SHEET 4 of 4

From attached North American Green modeling output:

S_{max} = 0.17 ft/ft or 17% slope

Qpeak = 0.6 cfs

Bottom width of ditch = 2 ft

Side slopes = 2:1

Lining type - North American Green S75 or equal

****

NORTH AMERICAN GREEN CHANNEL PROTECTION
USER SPECIFIED CHANNEL LINING ANALYSIS

****

PROJECT NAME: SST - MWRR2 RUNOFF DITCH
COMPUTED BY: GARY FISCHER
FROM STATION/REACH:
DRAINAGE AREA: 6 ACRES

PROJECT NO.: 9853493-110
DATE: 01-04-1999
TO STATION/REACH:
DESIGN FREQUENCY: 10-YR

Channel Bottom Width (ft)	Side Slope Lt. (Horz. to 1)	Side Slope Rt. (Horz. to 1)	Channel Slope (ft/ft)
2.00	2.0	2.0	0.170

Discharge (cfs)	Peak Flow Period (hrs)	Velocity (ft/sec)	Area (sf)	Hydraulic Radius (ft)	Normal Depth (ft)
0.6	4.0	2.40	0.25	0.10	0.11

Lining Type	Manning Coefficient	Permissible Shear (lb/sf)	Calculated Shear (lb/sf)	Safety Factor	Remark
S75 Staple D	0.055	1.55	1.19	1.30	STABLE

****

NORTH AMERICAN GREEN CHANNEL PROTECTION
USER SPECIFIED CHANNEL LINING BACK-UP COMPUTATIONS

****

PROJECT NAME: SST - MWRR2 RUNOFF DITCH
COMPUTED BY: GARY FISCHER

PROJECT NO.: 9853493-110
DATE: 01-04-1999

FROM STATION/REACH: TO STATION/REACH:
DRAINAGE AREA: 6 ACRES DESIGN FREQUENCY: 10-YR

****
INPUT PARAMETERS
****

Channel Discharge : 0.6 cfs
Peak Flow Period : 4.0 hours
Channel Slope : 0.170 (ft/ft)
Channel Bottom Width : 2.00 ft
Left Side Slope : 2.0:1
Right Side Slope : 2.0:1

Channel Lining Type : S75 Staple D Permissible Shear(Tp) : 1.55 psf

****
CALCULATIONS
****

Intial Depth Estimate = 0.16 * (0.6 /(0.170^0.5))^0.375	=	0.18 ft
Final Channel Depth (after 9 iterations)	=	0.11 ft
Flow Area = (2.00 * 0.11) + (0.5 * 0.11^2 * (2.0 + 2.0))	=	0.25 ft^2
Wet Perim. = 2.00+(0.11*(((2.0^2)+1)^.5 +((2.0^2) + 1)^.5))	=	2.50 ft
Hydraulic Radius = (0.25 / 2.50)	=	0.10 ft
Channel Velocity = (1.486 / 0.055) * (0.10^0.667) * (0.170^.5)	=	2.40 fps
Channel Effective Manning's Roughness	=	0.0550
Calculated Shear (Td) = 62.4 * 0.11 * 0.170	=	1.19 psf
Safety Factor = (Tp/Td) = (1.55 / 1.19)	=	1.30

****
NORTH AMERICAN GREEN CHANNEL PROTECTION
MATERIAL SPECIFICATIONS
****

S75 Erosion control blankets shall be a machine-produced mat of 100% agricultural straw.

The blanket shall be of consistent thickness with the straw evenly distributed over the entire area of the mat. The blanket shall be covered on the top side with a polypropylene netting having an approximate 1/2" x 1/2" mesh and be sewn together on 1.5" centers with biodegradable thread.

Straw erosion control blanket shall be S75 as manufactured by North American Green, or equivalent. Erosion control blanket shall have the following properties:

Material Content

Straw	100% (.50 lb/yd^2) (.27 kg/m^2)
Netting	One side only, photodegradable Weight approximately 1.64 lb/1,000 ft^2
Stitch	Degradable

Physical Specifications (Roll)

Width	6.5 feet (2m)
Length	83.5 feet (25.4m)
Weight	30 lbs (13.6kg) +/- 10%
Area	60 yd^2 (50 m^2)
Stitch Spacing	1.5" /> 50 per 6.5' roll width

MAXIM TECHNOLOGIES INC

BY G. FISCHER DATE 1/4/99

JOB TITLE SST - MWRR2 JOB NUMBER 9853493.110

SUBJECT Culverts SHEET 1 of 3

CULVERTS

Three (3) culverts are needed under Old Highway 10 for drainage in the area of MWRR2.

Criteria: 1. Try to use a standard size, approximately 18" dia

2. Hydraulic capacity for at least a 10-year return period.

Given: 1. 10-yr max flow for east culvert is approximately 4.2 cfs.

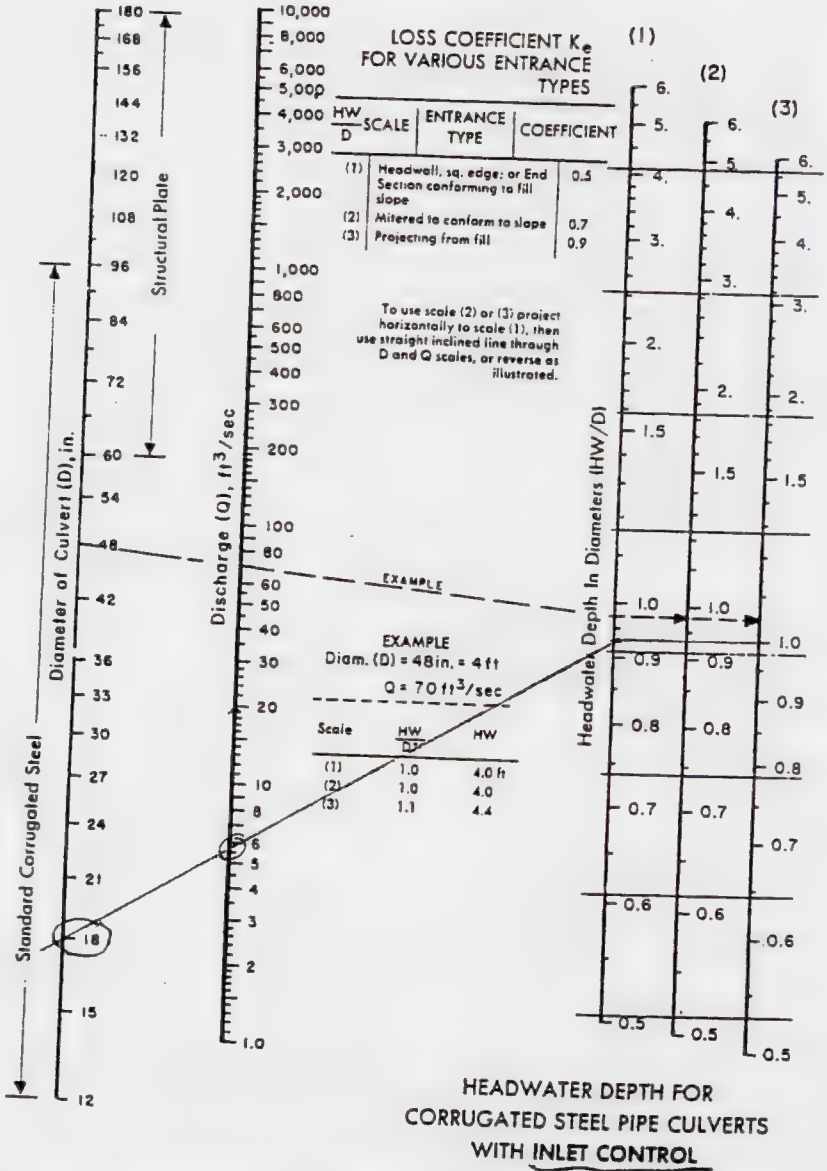
Computations:

From attached nomographs (Ref: Steel Drainage and Highway Construction Products, AISI, 1994), the maximum flow thru an 18" culvert with 1.0 ft of headwater is approximately 6 cfs, or nearly a 20-yr peak flow.

∴ Use 18" CMPs.

Improved Inlets

Culvert capacity may be increased through the use of special inlet designs. The Federal Highway Administration has developed extensive data[19,20] on these. While these designs increase the flow, their use has not been as expected. The increased costs of the special treatments is apparently responsible.


Standard Corrugated Steel
Diameter of Culvert (D), in.
Structural Plate
Discharge (Q), ft³/sec
LOSS COEFFICIENT Ke FOR VARIOUS ENTRANCE TYPES
HW/D SCALE
ENTRANCE TYPE
COEFFICIENT
(1) Headwall, sq. edge; or End Section conforming to fill slope 0.5
(2) Mitered to conform to slope 0.7
(3) Projecting from fill 0.9
To use scale (2) or (3) project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.
EXAMPLE
Diam. (D) = 48in. = 4ft
Q = 70 ft³/sec
Scale HW/D HW
(1) 1.0 4.0 ft
(2) 1.0 4.0
(3) 1.1 4.4
Headwater Depth in Diameters (HW/D)
(1)
(2)
(3)

HEADWATER DEPTH FOR CORRUGATED STEEL PIPE CULVERTS WITH INLET CONTROL

Figure 3.28 *Inlet control* nomograph for corrugated steel *pipe* culverts.[13] The manufacturers recommend keeping *HW/D* to a maximum of 1.5 and preferably to no more than 1.0 for diameters greater than 4 to 5 feet.

Figure 3.29 *Inlet control.* H

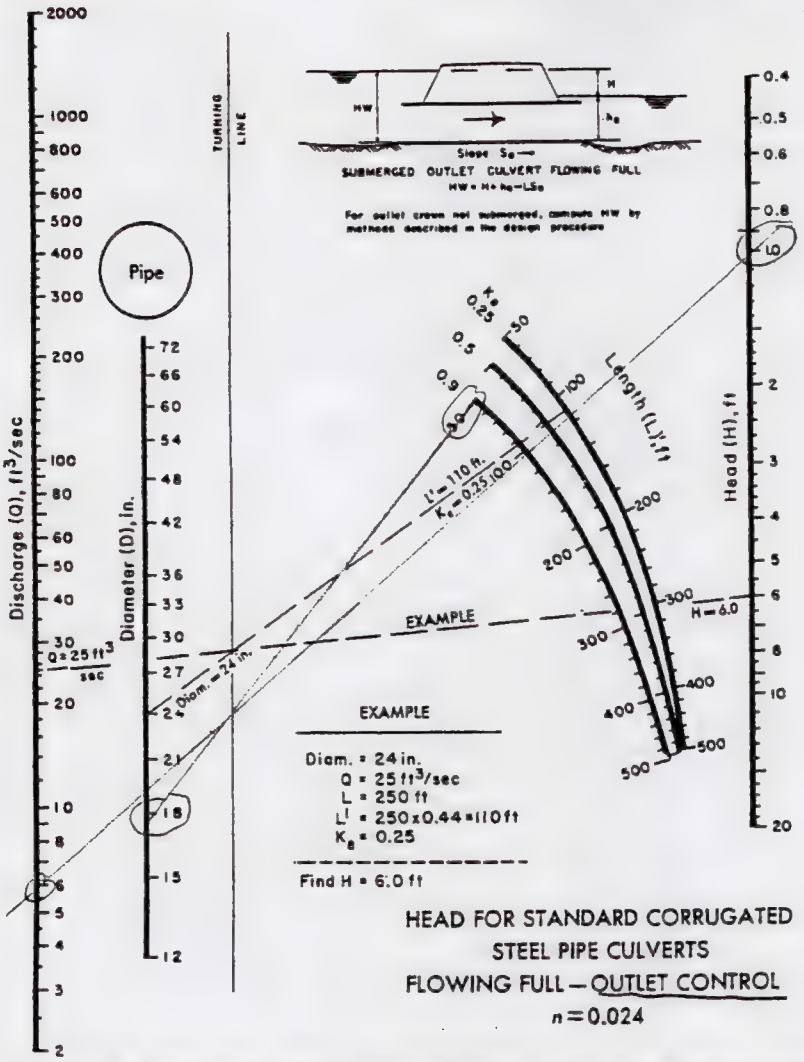

Discharge (Q), ft³/sec
Diameter (D), in.
Pipe
TURNING LINE
Length (L), ft
Head (H), ft
SUBMERGED OUTLET CULVERT FLOWING FULL
HW = H + h₀ − LS₀
For outlet crown not submerged, compute HW by methods described in the design procedure
EXAMPLE
Q = 25 ft³/sec
Diam. = 24 in.
L' = 110 ft.
Kₑ = 0.25
H = 6.0
EXAMPLE
Diam. = 24 in.
Q = 25 ft³/sec
L = 250 ft
L' = 250 x 0.44 = 110 ft
Kₑ = 0.25
Find H = 6.0 ft
HEAD FOR STANDARD CORRUGATED STEEL PIPE CULVERTS
FLOWING FULL — OUTLET CONTROL
n = 0.024

Figure 3.39 *Outlet control.* Head for corrugated steel *pipe* culvert with submerged outlet and culvert flowing full. See note under sketch at top.[13]

Table 3.11 Length Adjustment for Improved Hydraulics

Pipe Diameter, in.	Roughness Factor n' for Helical Corr.*	Length Adjustment Factor $\left(\frac{n'}{n}\right)^2$
12	0.011	0.21
24	0.016	0.44
36	0.019	0.61
48	0.020	0.70

*Other values of roughness, n, are applicable to paved pipe, lined pipe and pipe with 3 x 1 in. corrugations. See Table 3.9. To use the above chart for these types of pipe and pipe-arches, use adjusted length factors computed per Equation 16, page 151.

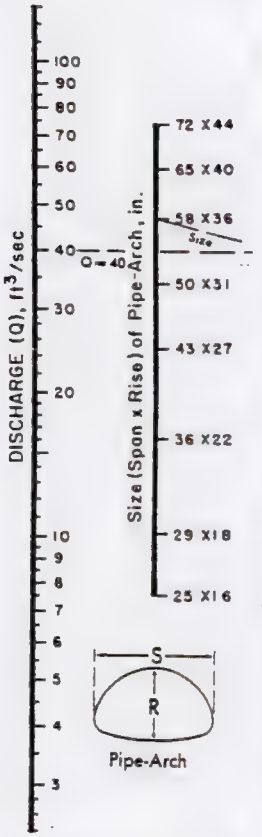


Figure 3.40 *Outlet contro* outlet arch flowing full.[13]

Figure 3.41 Structural pl

APPENDIX F-4

Geotechnical Evaluation

APPENDIX 3.4

MINE WASTE RELOCATION REPOSITORY 2
GEOTECHNICAL EVALUATION

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APPENDICES

ATTACHMENT A Figures and Tables

Figure 1 - Site Map
Table 1 - Slope Stability Analysis Results

ATTACHMENT B Boring Logs and Piezometer Information
ATTACHMENT C Tailings-Waste Composite Information
ATTACHMENT D In Situ Tailings-Waste Moisture Density
ATTACHMENT E Laboratory Testing Data
ATTACHMENT F Stabl 6H Computer Model Output Files

1.0 INTRODUCTION

The Montana Department of Environmental Quality (MDEQ) is planning a remedial action for the floodplain of Silverbow Creek located approximately one mile west of Butte, Montana. The remedial action will involve excavation and removal of mine waste material, including tailings. The remedial action will be completed for Reach A of Subarea 1, Steamside Tailings Operable Unit (SSTOU). The waste material from Reach A construction will be transported to a mine waste relocation repository for disposal. MWRR-2, located at the west end of Reach A, is proposed for use as a repository (Figure 1, Attachment A).

Maxim Technologies, Inc. (Maxim) has been retained by MDEQ for design of the remedial action, including the MWRR. This report presents the results of the geotechnical site investigation and geotechnical evaluation for MWRR-2.

2.0 PROJECT DESCRIPTION

An estimated 185,000 cubic yards of waste material will be removed from the floodplain of Reach A. Depth of excavation averages 2+/- feet over an area of approximately 40 acres. Clearing and grubbing will be completed to remove trees, shrubs, rootballs and debris which will be transported to a landfill for disposal. Topsoil present in the floodplain excavation area will be stripped and transported to the repository for disposal. Where the water table is above the base of the waste material excavation surface, dewatering will be required prior to excavation. The wastes will be amended with approximately 5 to 8 percent lime (dry weight basis) to reduce the acidity of the material prior to placement in the repositories. A final soil cover will be spread over the waste and the soil will be revegetated. Evapotranspiration effects by the vegetative cover will minimize the amount of precipitation which infiltrates into the repository.

The final constructed repository will have a footprint of approximately 8 acres and a total capacity of approximately 213,000 cubic yards, including cover soil. Waste storage capacity is approximately 198,000 cubic yards.

Runoff water upgradient from the repository will be diverted around the repository by drainage ditches sized to divert runoff from the 100 year, 24 hour precipitation event. A temporary construction haul road to the repository will be constructed. Underground utilities within the footprint of the repository will need to be relocated and a permanent access road around the repository constructed.

3.0 METHODS

3.1 FIELD EXPLORATION

Field exploration borings were completed by Maxim on December 5, 1997 (DH1) and January 8, 1998 (DH2 and DH3). Locations of the borings are shown on Figure 1. The Maxim drill crew advanced each boring through soil and bedrock material with a Mobile HD-61 truck-mounted drill rig using 7-inch diameter continuous flight hollowstem auger. Soil samples were obtained from boring DH-1 to a depth of 14 feet to collect information on the subsurface profile. Borings DH-2 and DH-3 were drilled to a depth of approximately eight feet before auger refusal. The exploratory borings were backfilled with auger cuttings upon completion of all drilling activities.

Samples of the subsurface materials were obtained with split barrel samplers, split barrel samplers equipped with California ring sample holders, and with Shelby tubes. The sampler was driven into the various strata using a 140-pound hammer falling 30 in. The sampler was driven 18-inches and penetration resistance values were recorded for each six inch increment. The first 6-inch increment is considered as "seating" of the sampler and the number of blows required to advance the sampler the next 12 inches was recorded as the penetration resistance (SPT or N value). Penetration resistance values provide an indication of the relative density of granular soils, or consistency of fine-grained soils. The split barrel equipped with California rings and the Shelby tubes were advanced by hydraulically pushing the tube in the soil stratum. Depths at which the samples were obtained and the penetration resistance values are shown on boring logs contained in Attachment B. Samples of soil obtained during the field exploration were observed and visually classified in accordance with ASTM D2487, which is based on the Unified Soil Classification System.

3.2 TAILINGS WASTE

A composite sample of tailings from the Streamside Tailings floodplain area was also obtained for characterizing the material which will be placed in the repository. The composite sample was prepared based on average grain size distribution and metal and arsenic concentrations of the tailings. Tailings/impacted soil test pit data available from the *Intermediate Design Report (ARCO, 1997)* were initially reviewed to identify representative material types of the tailings material. Approximately 40 test pits were randomly selected from the 435 test pits completed by ARCO for the Remedial Design and the test pit logs reviewed (Attachment C). Using a spatially selected sample group, lithologic data in the test pit logs showed that approximately 60 percent of the tailings material is composed of predominantly sand and gravel and the remaining 40 percent is silt and clay. Metal concentrations were also determined for a representative tailings/impacted soil by reviewing the median metal concentration for tailings/impacted soil in

Subarea 1 reported in the Remedial Investigation Report (ARCO, 1995) and then comparing these averages with the measured metals concentrations reported in the 40 test pits.

Based on the metals concentrations expected in a representative tailings/impacted soil sample, ten test pits containing tailings/impacted soils with similar arsenic and metals concentrations to the representative condition, were selected for resampling. The remedial design test pits included in this sampling are 1S-1031, 1N-1034,1S-1054, 1S-1087, 1N-1088, 1S-1139, 1S-1189,1DS-7019, SC-1007, and SC-1014 (Attachment C).

Selected test pits were located in the field using the locations staked by ARCO. The test pits were dug by hand in an undisturbed area directly adjacent to the initial test pits. Due to access restrictions, only nine of the ten test pits were able to be excavated. Sample pits were dug to a depth of approximately 2 feet. The wall of the pit was scraped of loose material and debris using a decontaminated stainless steel spoon. The soil profile was logged using visual soil classification methods. Samples were collected from coarse (sand and gravel) and fine (silt and clay) materials, and stored in separate plastic sample bags for each test pit location.

A composite tailings sample was prepared by mathematically combining appropriate percentages of each sample to obtain the 60-40 ratio of sand and gravel to silt and clay. This composite sample was analyzed by Maxim's laboratory to determine a lime application rate. The analysis indicated a lime application rate of 5.2%, dry weight basis, for a representative sample of lime kiln dust (produced by Continental Lime, Townsend, Montana) obtained from an on-site stockpile.

Density and moisture content of the tailings waste in the floodplain was evaluated by performing 45 in-place density tests using a Troxler Model 3411 nuclear densometer. Tests were spaced approximately every 550 feet along the length of Operable Unit 1 (27,300 feet). The field testing was performed by a Maxim field engineer trained for operating the nuclear densometer. Test results are summarized in Attachment D.

3.3 LABORATORY TESTING

The composite tailings sample was tested for gradation and moisture density relationships. The composite sample amended with lime was tested for gradation, moisture-density relationship, consolidation and shear strength using direct shear methods. Soil samples obtained from borings were tested for grain-size distribution, liquid-plastic limits and moisture content. Testing was performed by Maxim's laboratories located in Helena and Billings, Montana. Test results are presented in Attachment E.

4.0 SITE CHARACTERIZATION

4.1 LOCATION AND CLIMATE

The repository is located approximately 1 mile west of Butte, Montana and approximately 400 feet north of Silver Bow Creek. Elevations at site range from 5,410 to 5460 feet above mean sea level.

The site is situated in a semi-arid region with an average annual precipitation between 1941 and 1970 of 12 inches (USDA-SCS, 1977) and a mean annual evaporation rate from shallow lakes and reservoirs of 35 inches per year (USDA-SCS, 1974).

4.2 SITE ENGINEERING GEOLOGY

Soil at the site typically consists of sand and silty sand with lesser amounts of sandy silt. The soil material appears to be eroded from the granitic bedrock which underlies the site. Blow counts recorded for borings DH1, DH2 and DH3 indicate that the soil material is moderately dense. Loose saturated sand which may be susceptible to liquefaction was not encountered in the borings. Planar features susceptible to development of failure surfaces (e.g. clay layers, fault zones) were not encountered in the borings.

Bedrock at the site consists of granitic material of the Boulder Batholith (Smedes et. al., 1988). Field borings completed at the site indicate that depth to bedrock across the site is generally 10 feet or less, except in the southern area bordering the Silver Bow Creek valley bottom where depth to bedrock is likely at least 20 feet. Piezometers 1GW-1056 and 1GW-1057 installed by ARCO (Attachment B) indicate that depth to groundwater is approximately 10 to 20 feet below ground surface. At the location of piezometers 1GW-1056 and 1057 the water table is likely beneath the soil/bedrock interface.

Seismic information reviewed indicate that the geotechnical conditions in the project area are generally favorable for siting a repository. There are no recent faults (holocene age) within one-mile of Silver Bow Creek. The closest Holocene age fault appears to be the Vendome Horst, located between Butte and Whitehall, Montana, approximately 20 miles east of the project area (Stickney and Bartholomew, 1983). The bedrock acceleration in the project area has been estimated at 0.20g (20 percent of the force of gravity) with 90 percent probability of not being exceeded in 250 years (Algermissen, 1983).

4.3 REPOSITORY DESIGN

4.3.1 Tailings Waste Engineering Properties

Field and laboratory data for tailings material contained in Attachments C, D and E indicate the following.

- In-place tailings material in the floodplain has an average dry density of 95 pounds per cubic foot and moisture content of 19.74 percent.

- Testing of the composite sample of tailings material indicates a soil classification of silty sand, a maximum dry density (ASTM D698) of 118.5 lbs/cf and optimum moisture content of 13%.

- Testing of the lime amended composite sample of tailings material indicated a soil gradation of silty sand, a maximum dry density to 109.6 lbs/cf and a optimum moisture content to 16.9%. When compared to the unamended composite sample, the addition of lime appears to result in a lower maximum dry density and a higher optimum moisture content.

Results for consolidation and shear testing of the tailings material are discussed in the following two subsections.

4.3.2 Settlement

Settlement at the repository will occur due to consolidation of foundation soil and consolidation of tailings material placed in the repository. Settlement of the foundation soil will be negligible to very minimal due to the relatively shallow depth of natural soil overlying bedrock (approximately 10 feet or less) and because the soil is moderately dense sand with low settlement characteristics. Consolidation testing results for the amended tailings waste material indicates less than 6-inches of settlement for waste material placed to a maximum depth of 30 feet. Total settlement will be directly related to thickness of natural foundation soil, height of waste material and placement properties of the waste. Post-reclamation settlement is not expected to significantly alter surface grades such that ponding of water may result.

4.3.3 Slope Stability

The repository and foundation soils were evaluated for determining whether sliding surfaces may develop which could compromise the repository. The evaluation was conducted using the computer program PCSTABL, version 6.5 (USDOT, 1986) which determines factors of safety for failure surfaces which are systematically generated through the repository. The lowest factor of safety is used for determining the resistance of the repository to sliding failures for the conditions modeled. The modified Bishop Method, which generates circular failure surfaces, was used for the analysis.

Input data used in the PCSTABL analysis was obtained from testing data for amended tailings material and from literature values for sandy soil similar to that present in the repository foundation. Failure surfaces were not allowed to develop in the underlying bedrock. Descriptions of the conditions modeled and resulting factors of safety are presented in Table 1 (Attachment A). A seismic coefficient of 0.10 was used for the analysis based on the site bedrock acceleration of 0.20g (Algermissen, 1983) and recommendation that one-half this value be used for the seismic coefficient in pseudostatic analyses (Hynes and Franklin, 1984). Attachment F contains the computer output files.

In the case of the static- and pseudostatic evaluations completed for unsaturated soil conditions (Table 1) the calculated factors of safety are higher than the allowable minimum factor of safety. These two conditions represent the most likely set of characteristics for the repository. Additional modeling was completed to evaluate the susceptibility of the repository to failure if the foundation soil and the lowermost layer of tailings material becomes saturated with groundwater. The modeling for this condition also indicates an acceptable factor of safety for the repository design.

5.0 RECOMMENDATIONS

The following recommendations are provided for constructing the repository.

- All topsoil present within the footprint of the repository should be removed prior to placing the tailings waste material.

- Waste material should be placed in the repository in horizontal lifts and compacted to 90 or 95 percent of the maximum dry density (ASTM D698). Addition of the lime amendment should improve the moisture content needed to achieve compaction, however drying or wetting of the material may be necessary to achieve the compaction requirements. Compacted lift thickness should not exceed 12 inches. A field test program is recommended to establish project specific placement parameters such as lift thickness, traffic patterns, compaction effort and equipment requirements.

- Soil stripped from the floodplain and tailings waste material should be monitored during placement to insure a uniform mixture of wastes to prevent development of layers of low strength which may affect settlement or stability. Selective soil placement may be required. In general, lower strength material should be placed within the center of the repository or in other areas which would not compromise the repository stability.

6.0 REFERENCES

Algermissen, S.T., Perkins, D.M., Thenhaus, P.C., Hanson, S.L., Bender, B.L. 1983. Probabilistic Earthquake Accelerations and Velocity Maps for the United States and Puerto Rico. Miscellaneous Field Studies. United States Geological Survey.

ARCO. 1997. Silver Bow Creek/Butte Area NPL Site (NPL). Streamside Tailing Operable Unit. Intermediate Design Report. July 1997.

Hynes, M.E. and Franklin, A.G. 1984. Rationalizing the seimisc coefficient method: U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi, Miscellaneous Paper GL-84-13. July 1984.

Stickney. 1987. Preliminary Map of Late Quarternay Faults in Western Montana. Open File Report 186. Montana Bureau of Mines and Geology.

Smedes, H.W., Klepper, M.R., Tilling, R.I., 1988. Preliminary Map of Plutonic Units of the Boulder Batholith, Southwestern Montana. U.S. Geologic Survey

United States Department of Agriculture, Soil Conservation Service, 1977. Average Annual Precipitation, Montana, based on 1941-1970 base period. USDA-SCS Portland, Oregon.

United States Department of Agriculture, Soil Conservation Service, 1974. Evaporation Pond Design for Agriculture Wastewater Disposal, Montana Technical Note: Environment No. 7. February.

United States Department of Transportation, 1986. PC-STABL6 Users Guide. Turner-Fairbank Highway Research Center, McLean, VA.

ATTACHMENT A

FIGURES AND TABLES

TABLE 1
SLOPE STABILITY ANALYSIS RESULTS, MWRR-2

Modeled Condition	Factor of Safety	Allowable Minimum Factor of Safety[1]
Static-Unsaturated. No seismic loads, unsaturated tailings and soil.	2.8	1.5
Static-Saturated. No seismic load, tailings saturated to depth of 10'	2.6	1.5
Pseudostatic-Saturated Conditions, Drained (i.e. no excess pore pressures). Seismic loading - seismic coefficient of 0.10, saturated foundation soil and saturated tailings to a depth of 10 feet.	1.80	1.3

[1] EPA Guide to Technical Resources for the Design of Land Disposal Facilities, EPA/625/6-88/018, U.S. EPA, 1988.

ATTACHMENT B

BORING LOGS
AND
PIEZOMETER INFORMATION

MAXIM TECHNOLOGIES INC

LOG OF EXPLORATION BORING (FIELD)

PROJECT: Streamside Tailings - Mine Waste Repository
JOB NO.:
DRILL TYPE: SOIL Mobile B-61 HSA.
ROCK
DRILLED BY: Paul Bray (MAXIM)
LOGGED BY: Pete Mommsen
REMARKS:

HOLE NO. DH-1 ; MWRR-2
SHEET 1 OF 1
LOCATION 110' N. of centerline old Highway 10, ~4 miles E. of Rockel
ELEVATION: TOP OF HOLE
GROUNDWATER N.E.
NEXT DAY
DATE: HOLE STARTED 12-5-97
HOLE COMPLETED 12-5-97

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
0'	Silty SAND with gravel, medium dense, fine to very coarse, fine gravels, moist, dark brown to brown	Grab	1.0'	2.5'	Bag Sample							
		SS	2.5'	4.0'		7	7	10	17			
		Grab	4.5'	7.0'	BAG							
7'	Clayey SAND with gravel, very dense, fine to very coarse grained, fine gravels, moist, light tan	SS	7.5'	9.0'		7	11	13	24			
		SS	10.0'	11.5'		8	16	14	30			
11.3'	SAND with gravel, medium dense, fine to very coarse, moist, rust colored	SS	12.5'	14.0'		16	21	24	45			
	13' = Clayey SAND with gravel lenses, dense, fine to very coarse grained, fine gravels, moist, rust to brown to light grey, occasionally mottled											
12.5'	Bottom of Hole											

MAXIM
TECHNOLOGIES INC

LOG OF EXPLORATION BORING (FIELD)

PROJECT: Stream Side Tailings; Mine Waste Repository
JOB NO.:
DRILL TYPE: SOIL Mobile B-61 HSA.
ROCK
DRILLED BY: Paul Bray (Maxim)
LOGGED BY: S. COLVIN
REMARKS:

HOLE NO. DH-2; MWRR-2
SHEET 1 OF 1
LOCATION North (upgradient) end of repository site
ELEVATION: TOP OF HOLE
GROUNDWATER NE
NEXT DAY
DATE: HOLE STARTED 1-8-98
HOLE COMPLETED 1-8-98

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
0'	Silty LOAM, frozen	SS	0.0'	0.5'	0.2'	50/3			Frozen			
0.2'	Silty SAND, medium to coarse grained, minor small gravels, angular, dry, gray	SS	0.5'	1.0'	0.3'	50/3			Frozen			
	2.5' = Shelby push	ST	2.5'	4.2'					Shelby Tube			
4.0'	SAND, slightly silty to very weathered granite bedrock, angular, dry, gray	SS	4.0'	5.5'	1.5'	38	43	45	88			
		SS	5.5'	7.0'	1.5'	22	45	33	78			
	7.0' = Shelby push (no recovery)											
7.2'	Refusal, Bottom of Hole	ST	7.0'	7.1'	0							

MAXIM
TECHNOLOGIES INC

LOG OF EXPLORATION BORING (FIELD)

PROJECT: Streamside Tailings Mine Waste Repository
JOB NO.:
DRILL TYPE: SOIL Mobile B-61 HSA
ROCK
DRILLED BY: Paul Bray (MAXIM)
LOGGED BY: S. COLLIN
REMARKS:

HOLE NO. DH-3; MWRR-2
SHEET 1 OF 1
LOCATION South end of repository
ELEVATION: TOP OF HOLE
GROUNDWATER NE
NEXT DAY
DATE: HOLE STARTED 1-8-98
HOLE COMPLETED 1-8-98

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
0.0'	Silty LOAM											
0.2'	Very silty SAND, slightly clayey, fine to medium grained, slightly moist, brown	SS	1.0'	2.5'	0.9'	24	36	37	73			
	1.5' = well graded, silty, gray-brown	ST	2.5'	4.5'	2.0'				Shelby Tube			
		RS	4.5'	6.0'	0.8'				Ring Sample			
6.5'	Weathered Granite BEDROCK to SAND, dense, medium to coarse grained, gravelly, gray	SS	6.0'	7.5'	1.1'	30	26	49	75			
		SS	7.5'	8.6'	0.8'	39	50/4	50/2	100/6			
8.6'	Refusal, Bottom of Hole											

Table 7.2
Piezometer Ground Water Level Monitoring Data - Subarea 1
Streamside Tailings Operable Unit

assume 3' stick-up

Piezometer Identification (5)	Survey Data (1)			Date	Depth to Water (ft) bgs (TOC) (2)	Ground Water Elevation (3)
	Northing	Easting	TOC Elevation (ft)			
				18-Apr-97	17.97	5362.82
				3-Jul-97	18.25	5362.54
IGW-1042	745540.5911	1209170.3206	5377.96	18-Mar-97	14.88	5363.08
				24-Mar-97	13.90	5364.06
				18-Apr-97	13.60	5364.36
				3-Jul-97	13.75	5364.21
IGW-1043	745429.3716	1208706.2453	5383.75	18-Mar-97	21.10	5362.65
				24-Mar-97	19.94	5363.81
				18-Apr-97	19.44	5364.31
				3-Jul-97	19.60	5364.15
IGW-1044	745679.3755	1208326.3308	5376.94	18-Mar-97	15.24	5361.70
				24-Mar-97	13.70	5363.24
				18-Apr-97	14.01	5362.93
				3-Jul-97	14.00	5362.94
IGW-1056	745295.1814	1216152.2378	5432.39	18-Mar-97	11.65 14.68	5417.71
				24-Mar-97	11.40 14.40	5417.99
				18-Apr-97	11.41 14.41	5417.98
				3-Jul-97	11.70 14.70	5417.69
IGW-1057	745318.6181	1216647.0696	5435.82	18-Mar-97	10.56 11.56	5424.26
				24-Mar-97	19.20 22.20	5413.62
				18-Apr-97	19.01 22.01	5413.81
				3-Jul-97	19.25 22.25	5413.57
C-15			5413.70	3-Jul-97	2.90	5410.80
C-16			5405.12	3-Jul-97	3.70	5401.42
C-17			5405.27	3-Jul-97	3.35	5401.92
MW-01	745913.83	1209358.23	5368.19	3-Jul-97	3.90	5364.29
MW-02	745975.72	1208773	5370.31	3-Jul-97	7.85	5362.46
MW-04	746054.15	1208342.7	5367.05	3-Jul-97	6.35	5360.70
MW-5	746129.56	1207660.42	5365.03	3-Jul-97	5.50	5359.53
MW-6	746263.68	1207603.7	5363.53	3-Jul-97	4.90	5358.63
MW-7	746130.49	1207358.45	5362.47	3-Jul-97	4.90	5357.57
MW-8	746370.52	1208444.23	5371.79	3-Jul-97	ND	--
MW-9	746337.7	1208369.37	5370.54	3-Jul-97	9.55	5360.99
MW-10	746271.58	1208256.27	5363.89	3-Jul-97	3.25	5360.64
MW-11	746166.58	1208163.8	5362.78	3-Jul-97	2.80	5359.98

Notes:

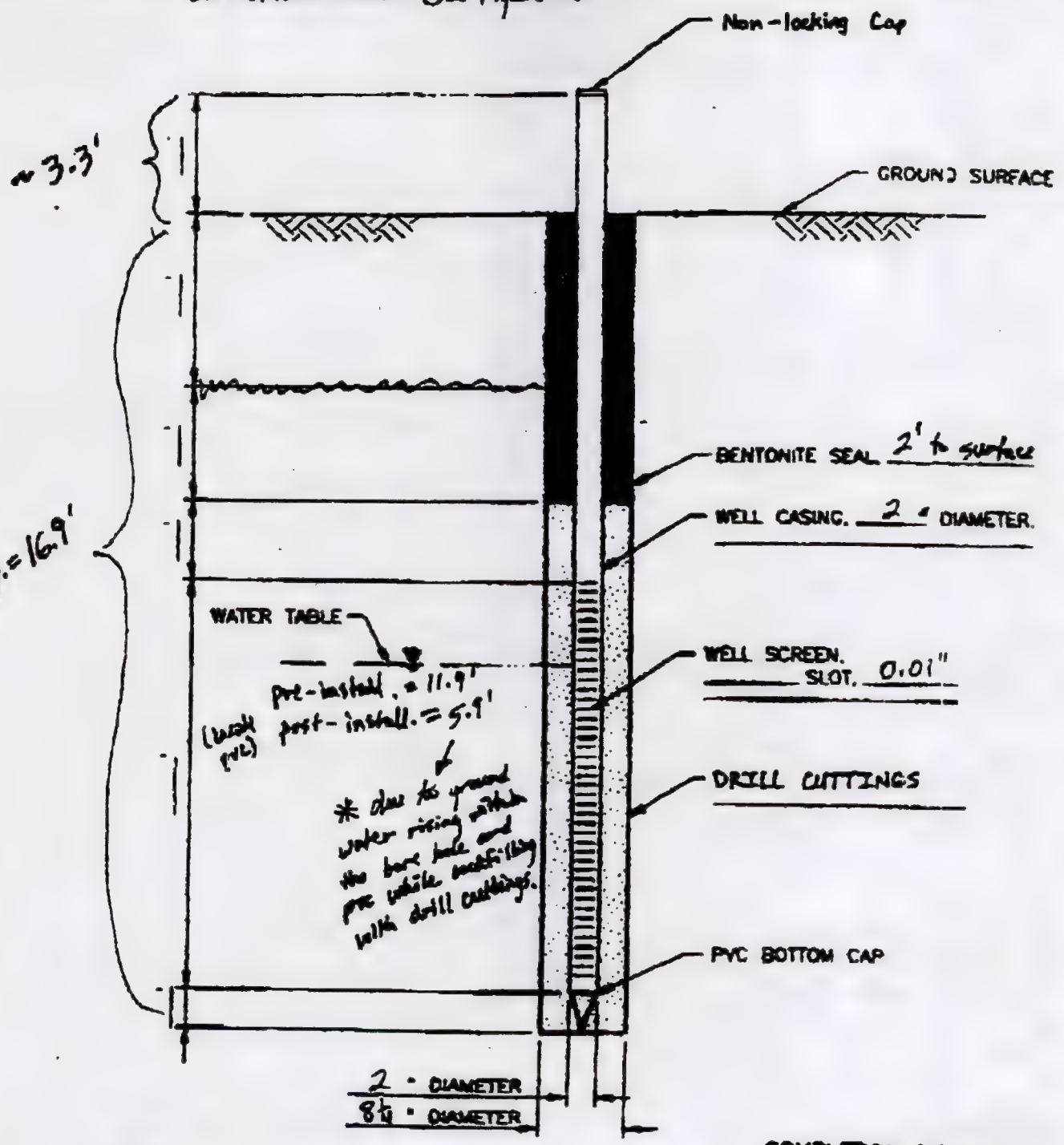
1. Survey information provided by Druyvestein, Johnson and Anderson. All elevations are presented in feet above mean sea level
2. All water levels are measured from a mark on the top of the PVC casing (TOC.)
3. Ground water elevations determined by subtracting depth to ground water from the surveyed elevation
4. Depth to water below ground surface (BGS)
5. Locations of piezometers are presented on Sheets 4a through 4e of drawings
6. Relocation areas are presented on Sheets 7a through 7i of the drawings
7. Borrow area locations are presented on Sheets 6a through 6e of the drawings
8. Potential borrow areas are pending agency approval based on evaluation using alternative borrow source material criteria
9. * = Depth to ground water is greater than piezometer installation depth. Piezometer was installed to greatest depth possible before reaching a hard, consolidated formation
10. ** = Ground water elevation not determined--dry well.

02/13/98 11:37 SCHAFER AND ASSOC BOZEMAN → 1 406 449 3729
406 587 0331
NO.050 P002/004

TITAN Environmental

Well/Piezometer Completion Detail

Project Name SST BM
Project No. 6114-205
Boring Location North side of Highway 10 ± East of Old Bluebird Mkt. (See Figure 3b.)
Well No. MW-1056
3/17/97



COMPLETION DETAIL

NOTE:
1. THIS DRAWING IS NOT TO SCALE.

02/13/98 11:37 SCHAFER AND ASSOC BOZEMAN → 1 406 449 3729 NO.050 P003/004
406 587 0331
06/12/97 08:00 1 406 585 0625 TITAN ENVIRONMENTAL JUN-10-1997 01:33
1 406 585 0625 P.34

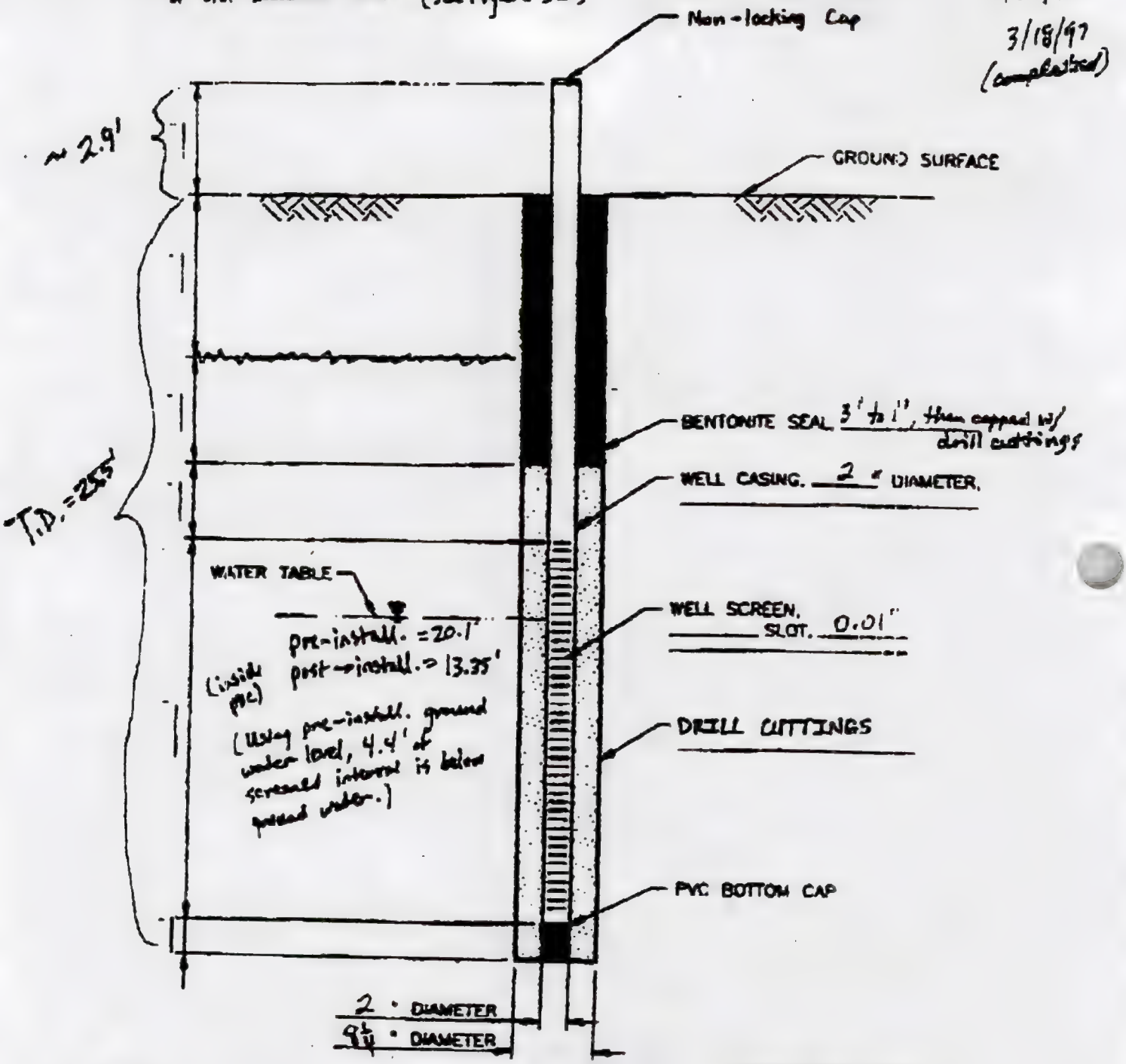
TITAN Environmental

Well/Piezometer Completion Detail

Project Name SST 04
Boring Location North of old Highway 10 and east of old Bluebird mill. (See Figure 3b.)

Project No. 6114-005
Well No. 6W-057

3/17/97 – 3/18/97 (completed)



COMPLETION DETAIL

NOTE:

1. THIS DRAWING IS NOT TO SCALE.
2. Used 2 five foot sections of screened interval to cover the loamy sand layers.

ATTACHMENT C

TAILINGS AND WASTE COMPOSITE INFORMATION

TABLE A1
SELECTED TEST PIT LOG INFORMATION

Test Pit #	Tailings Depth (ft)	Tailings Depth + 6 inches (ft)	Coarse Portion Sands and Gravels (feet)	Fine Portion Silts and Clays (feet)	Groundwater Depth (feet)	Saturated Coarse Portion (feet)	Saturated Fine Portion (feet)
1010	4.33	4.83	3.43	1.40	5.00	0.00	0
1018	1.67	2.17	0.00	2.17	3.00	0.00	0.00
1026	0.00						
1035	0.33	0.83	0.83	0.00	3.50	0.00	0.00
1046	2.33	2.83	2.83	0.00	1.70	1.13	0.00
1055	0.00	0.50	0.00	0.00			
5005	2.67	3.17	1.00	2.17	3.20	0.00	0.00
1074	1.67	2.17	0.50	1.67	3.50	0.00	0.00
1084	3.00	3.50	3.50	0.00	1.70	1.80	0.00
1093	1.33	1.83	0.50	1.33	1.60	0.00	0.23
BB1002	0.00						
BB1011	0.33	0.83	0.00	0.83	4.50	0.00	0.00
BB1008	1.83	2.33	2.33	0.00	3.70	0.00	0.00
1098	1.00	1.50	1.50	0.00	2.80	0.00	0.00
1113	0.33	0.83	0.00	0.83	6.00	0.00	0.00
1123	0.00						
1132	0.00						
1142	4.67	5.17	3.50	1.67	0.67	4.17	1.00
1151	0.00						
1167	1.67	2.17	1.50	0.67	4.00	0.00	0.00
7003	4.33	4.83	4.83	0.00	3.10	1.73	0.00
7015	0.00						
7023	7.67	8.17	4.17	4.00	7.00	0.00	0.00
7034	2.33	2.83	1.33	1.50	4.20	0.00	0.00
1178	1.00	1.50	0.83	0.67	3.90	0.00	0.00
1185	4.00	4.50	3.50	1.00	3.00	1.00	0.50
3009	2.33	2.83	0.50	2.33	2.40	0.43	0.00
1203	0.67	1.17	0.00	1.17	3.67		
1211	1.33	1.83	1.83	0.00	1.50	0.33	0.00
1221	3.00	3.50	3.50	0.00	2.50	1.00	0.00
1232	0.67	1.17	0.42	0.75	1.40	0.00	0.00
1241	1.00	1.50	0.00	1.50	4.25	0.00	0.00
1263	0.00						
1276	1.00	1.50	1.50	0.00	1.70	0.00	0.00
1285	2.67	3.17	1.17	2.00	1.10	1.10	0.90
1294	2.67	3.17	1.42	1.75	5.00	0.00	0.00
SC1026	0.33	0.83	0.83	0.00	1.50	0.00	0.00
SC1014	2.25	2.75	1.25	1.50	5.10	0.00	0.00
SC1019	1.67	2.17	0.67	1.50	4.20	0.00	0.00
SC1006	2.17	2.67	2.17	0.50	6.50	0.00	0.00
averages		**2.65**	**1.60**	**1.03**	**3.45**	**nc**	**nc**

notes:
Depth to groundwater varies seasonally
nc - not calculated

TABLE A-12
COMPOSITE TAILINGS SAMPLE MAKEUP
Leachate and Attenuation Study

Test Pit Number	Percent Moisture	Percent Dry Weight In Composite
Coarse Fraction (Sand & Gravel)		
IS-1054	6.8	6.7
SC-1014	23.5	6.7
IN-1088	17.5	6.7
IS-1031	14.9	6.7
IDS-7019	10.1	6.7
SC-1007	4.7	6.7
IS-1189	10.2	6.7
IN-1034	6.8	6.7
IS-1087	5.9	6.7
Total Percent Coarse Fraction		60
Fine Fraction (Silt & Clay		
SC-1014	26.3	10
IN-1088	39.3	10
IDS-7019	14.3	20
Total Percent Fine Fraction		40

MAXIM
HNOLOGIES INC

Test Pits

LOG OF EXPLORATION ~~BORING (FIELD)~~

PROJECT: Stream Side Tailings
JOB NO.: 973701.130
DRILL TYPE: SOIL —
Dug ROCK
~~DRILLED~~ BY: Todd Kuykendall / Matt Werner
LOGGED BY: Todd Kuykendall
REMARKS:

HOLE NO. Silt & Sand Samples
SHEET 1 OF 1
LOCATION(S) Behind Flying J (Silt) Excavated area South of Water Treatment Plant
ELEVATION: TOP OF HOLE
GROUNDWATER
NEXT DAY
DATE: HOLE STARTED
HOLE COMPLETED

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
	Sample											
0.0 – 0.1	Topsoil & Sluff				Silt Sample Collected near base of cut approximately 20' below pre-existing grade							
0.1 – 2.0	Silt w/ Sand, tan, moist	S										
	Sample											
0.0 – 0.2	Topsoil & Sluff											
0.2 – 1.0	Silty Sand, tan, moist	S										

MAXIM
HNOLOGIES INC

LOG OF EXPLORATION ~~BORING (FIELD)~~ Test Pit

PROJECT: Stream Side Tailings

JOB NO.: 9731701.130

DRILL TYPE: SOIL —
Duy ROCK

~~DRILLED~~ BY: Todd Kuxhaus / Matt Warner

LOGGED BY: Todd Kuxhaus

REMARKS: ASTM D2488, Visual Class.

HOLE NO. IS-1031

SHEET 1 OF 1

LOCATION Next to previous Test Pit

ELEVATION: TOP OF HOLE
GROUNDWATER
NEXT DAY

DATE: HOLE STARTED
HOLE COMPLETED

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
0.0												
0.4	Silty Sand, Brown, moist organics present											
0.8												
2.0	Poorly Graded Sand, Orange-Brown wet	S										
2.0												
2.2	Silt, Grey, wet											

MAXIM
HNOLOGIES INC

Test P.t.

LOG OF EXPLORATION ~~BORING~~ (FIELD)

PROJECT: Stream Side Tailings
JOB NO.: 9731701.130
DRILL TYPE: SOIL —
ROCK
Dug
~~DRILLED~~ BY: Todd Kuxhaus - Matt Warner
LOGGED BY: Todd Kuxhaus
REMARKS: Visual ASTM D2488

HOLE NO. TP-1034
SHEET 1 OF 1
LOCATION Next to previous Test P.t
ELEVATION: TOP OF HOLE
GROUNDWATER
NEXT DAY
DATE: HOLE STARTED
HOLE COMPLETED

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
0-.8	Silty Sand, Brown, moist organics present											
.8-2.2	Silty Sand with Gravel, Brown-Orange, moist, interbedded lenses of Poorly graded sand	S										

AXIM
OLOGIES INC

Test Pit

LOG OF EXPLORATION ~~BORING (FIELD)~~

PROJECT: Stream Side Tailings

JOB NO.: 973(701.130)

DRILL TYPE: SOIL
ROCK
Dug

~~DRILLED~~ BY: Todd Kuykendall / Matt Warner

LOGGED BY: Todd Kuykendall

REMARKS:

HOLE NO. TS - 1054

SHEET 1 OF 1

LOCATION Next to Previous Test Pit

ELEVATION: TOP OF HOLE
GROUNDWATER
NEXT DAY

DATE: HOLE STARTED
HOLE COMPLETED

CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
Well Graded Sand with Gravel, Brown - Orange, moist	S										
Well Graded Gravel w/ Sand, orange, moist	S										
Sandy ^ Well Graded Gravel w/ Cobbles moist, Gray - Green	S										

MAXIM
ENGINEERING INC

LOG OF EXPLORATION ~~BORING (FIELD)~~ Test Pit

PROJECT: Stream Side Tailings
JOB NO.: 973701.130
DRILL TYPE: SOIL ~ Dug
ROCK
DRILLED BY: Todd Kuxhaus / Matt Warner
LOGGED BY: Todd Kuxhaus
REMARKS:

HOLE NO. LS-1087
SHEET 1 OF 1
LOCATION West to Previous Test Pit
ELEVATION: TOP OF HOLE
GROUNDWATER
NEXT DAY
DATE: HOLE STARTED
HOLE COMPLETED

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
0.0-0.8	Silty Sand, moist, Grey-Brown organics present											
0.8-2.0	Sand w/ Gravel, orange-Brown, wet, distinct ~~odor~~ odor, appear to be effervescing, suspect low pH	S										

MAXIM
E HNOLOGIES INC

LOG OF EXPLORATION ~~BORING~~ Test Pit (FIELD)

PROJECT: Stream Side Tailings

JOB NO.: 973170I.130

DRILL TYPE: SOIL —

ROCK

~~DRILLED~~ Dug BY: Todd Kuykendall & Matt Warner

LOGGED BY: Todd Kuykendall

REMARKS: ASTM D2488

HOLE NO. IN-1088

SHEET 1 OF 1

LOCATION Adjacent to Previous location

ELEVATION: TOP OF HOLE NA

GROUNDWATER "

NEXT DAY "

DATE: HOLE STARTED NA

HOLE COMPLETED "

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
0.0-1.0	Sandy Silt, Gray, Moist, organics present											
1.0-2.2	Coarse Sand, orange, Moist	S										
2.2-2.6	Sandy Silt, Gray, Moist	S										

MAXIM
HNOLOGIES INC

Test Pit

LOG OF EXPLORATION ~~BORING (FIELD)~~

PROJECT: Streams Side Tailings
JOB NO.: 973701.130
DRILL TYPE: SOIL —
Dry ROCK
~~DRILLED~~ BY: Todd Kuykendall / Matt Warner
LOGGED BY: Todd Kuykendall
REMARKS:

HOLE NO. TS-1659
SHEET 1 OF 1
LOCATION NA

ELEVATION: TOP OF HOLE
GROUNDWATER
NEXT DAY
DATE: HOLE STARTED
HOLE COMPLETED

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
	Not Accessible - Under Water											

MAXIM
ENGINEERING TECHNOLOGIES INC

LOG OF EXPLORATION ~~BORING (FIELD)~~ Test Pit

PROJECT: Stream Side Tailings

JOB NO.: 273701.130

DRILL TYPE: SOIL —
Dug ROCK

DRILLED BY: Todd Kuxhaus / Matt Warner

LOGGED BY: Todd Kuxhaus

REMARKS:

HOLE NO. IS-189

SHEET 1 OF 1

LOCATION Next to Previous test Pit

ELEVATION: TOP OF HOLE
GROUNDWATER
NEXT DAY

DATE: HOLE STARTED
HOLE COMPLETED

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	BLOWS OF HAMMER 2nd 6"	BLOWS OF HAMMER 3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	ESTIMATED SAND	ESTIMATED -200
0.0	Fine Sand, moist, Brown,											
2.8	organics present											
0.8	Sandy Silt, moist, Grey	S										
1.1	Well Graded Sand, orange-Brown	S										
2.2	moist											

AXIM
OLOGIES INC

Test P.t

LOG OF EXPLORATION ~~BORING (FIELD)~~

PROJECT: Stream Side Tailings
JOB NO.: 9731701.130
DRILL TYPE: SOIL —
Dug ROCK
DRILLED BY: Todd Kuykendall/Matt Warner
LOGGED BY: Todd Kuykendall
REMARKS:

HOLE NO. TDS - 701C
SHEET 1 OF 1
LOCATION ~~Next~~ to Previous Test Pit
ELEVATION: TOP OF HOLE
GROUNDWATER
NEXT DAY
DATE: HOLE STARTED
HOLE COMPLETED

CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
Silty Sand, moist, Brown											
Sandy Silt, Grey, moist	S										
Fine Sand, Brow, moist	S										

MAXIM
INOLOGIES INC

LOG OF EXPLORATION ~~BORING (FIELD)~~ Test Pit

PROJECT: Stream Side Tailings

JOB NO.: 473401.130

DRILL TYPE: SOIL —
ROCK

~~DRILLED~~ Dug BY: Todd Kuxhaus / Matt Wagner

LOGGED BY: Todd Kuxhaus

REMARKS:

HOLE NO. SC-1007

SHEET 1 OF 1

LOCATION Next to Previous Test Pit

ELEVATION: TOP OF HOLE
GROUNDWATER
NEXT DAY

DATE: HOLE STARTED
HOLE COMPLETED

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
0.0 – 2.4	Silty Fine Sand, moist, Gray – Brown											
0.4 – 2.8	Silty Fine Sand, Gray Brown, moist, organics present											
2.8 – 3.8	Coarse Sand w/ Gravel, Orange – Brown, moist	S										

AXIM
JOLOGIES INC

LOG OF EXPLORATION ~~BORING (FIELD)~~ Test Pit

PROJECT: Stream Side Tailings

JOB NO.: 9731701.130
DRILL TYPE: SOIL ✓
ROCK
~~DRILLED~~ Dug BY: Todd Kirchhoff / Matt Warner
LOGGED BY: Todd Kirchhoff
REMARKS:

HOLE NO. SC-1014
SHEET 1 OF 1
LOCATION Next to Previous Test Pit
ELEVATION: TOP OF HOLE
GROUNDWATER
NEXT DAY
DATE: HOLE STARTED
HOLE COMPLETED

DEPTH	CLASSIFICATION AND DESCRIPTION	SAMPLE SYMBOL	DEPTH FROM	DEPTH TO	LENGTH OF SAMPLE RECOVERED	BLOWS OF HAMMER 1st 6"	2nd 6"	3rd 6"	S.P.T. (N) (BLOWS/FT.)	ESTIMATED GRAVEL	SAND	-200
	Sandy Silt, moist, Gray + Orange	S										
	Silty Fine Sand, Gray + Orange, moist	S										

ATTACHMENT D

IN PLACE TAILINGS WASTE DENSITY INFORMATION

SST - TAILINGS IN-PLACE DENSITY FIELD SURVEY
TESTS PERFORMED ON 12/4/97
ALL TEST AT TAILINGS SURFACE

TEST LOCATION	DRY DENSITY (PCF)	WET DENSITY (PCF)	MOISTURE (%)	DRY DENSITY W/ OUT OUTLIER (PCF)
50' S OF 1N-1013	77.6	107.6	38.7%	77.6
150' S OF 1N-1019	68.5	98.1	43.2%	68.5
100' SE OF 1N-1025	74.4	101.4	36.3%	74.4
100' SW OF 1N-1029	54.8	84.6	54.4%	
15' W OF 1N-1038	84.8	101.2	19.3%	84.8
100' E OF 1N-1041	85.7	99.0	15.5%	85.7
30' W OF 1S-1051	115.3	119.4	3.6%	115.3
40' N OF 1S-1075	104.9	117.3	11.8%	104.9
50' NE OF 1S-1087	111.8	115.6	3.4%	111.8
50' S OF 1N-1092	100.9	107.8	6.8%	100.9
100' E OF 1S-1098	104.5	119.5	14.4%	104.5
50' NE OF 1S-1116	89.4	111.2	24.4%	89.4
100' S OF 1N-1131	75.3	100.3	33.2%	75.3
100' W OF 1N-1128	79.3	106.4	34.2%	79.3
30' NE OF 1N-1143	118.5	128.1	8.1%	118.5
100' NE OF 1DN-7002	86.1	104.0	20.8%	86.1
100' N OF 1DS-7009	70.2	88.2	25.6%	70.2
50' N OF 1DN-7024	96.7	102.0	5.5%	96.7
50' NW OF 1DN-7025	79.5	97.7	22.9%	79.5
200' E OF 1DN-7036	83.2	100.6	20.9%	83.2
50' S OF 1N-1178	109.5	112.3	2.6%	109.5
[illegible] OF 1N-1187	110.6	118.0	6.7%	110.6
[illegible]S OF 1N-1196	80.1	100.8	25.8%	80.1
10' N OF 1S-1221	120.9	124.1	2.6%	120.9
10' N OF 1N-1228	90.9	113.6	25.0%	90.9
60' N OF 1S-1231	114.5	119.7	4.5%	114.5
100' N OF 1S-1259	59.0	95.5	61.9%	
100' N OF 1S-1263	92.1	120.7	31.1%	92.1
100' N OF 1S-1264	107.8	112.9	4.7%	107.8
150' NW OF 1S-1265	100.1	125.8	25.7%	100.1
50' SE OF 1N-1275	110.2	121.0	9.8%	110.2
200' NW OF 1S-1278	120.3	125.0	3.9%	120.3
100' NW OF 1S-1280	83.6	98.9	18.3%	83.6
60' NW OF 1N-1281	81.0	98.5	21.6%	81
60' SW OF 1N-1285	87.6	109.3	24.8%	87.6
100' SW OF 1N-1289	92.6	114.5	23.7%	92.6
225' W OF 1S-1293	109.3	119.1	9.0%	109.3
75' S OF 1N-1297	73.2	94.2	28.7%	73.2
25' S OF 1N-5015	122.1	127.3	4.3%	122.1
50' W OF 1S-1005	109.3	122.4	12.0%	109.3
AVERAGES	93.40	109.59	19.74%	
			AVERAGE W/ OUT OUTLIERS	95.32

DE[illegible]SITIES LOWER THAN 62.4 (WATER) NOT INCLUDED. SUBSURFACE VOIDS ENCOUNTERED.

ATTACHMENT E

LABORATORY TESTING DATA

TABLE E-1
PHYSICAL MATERIAL TEST PROCEDURES

Characteristic	Test Method	Explanation
Moisture Content	ASTM D2216 and C602	Based on wet and dry weights, the moisture content is determined and reported in percent moisture.
Visual Classification	ASTM D2488	Based on visual estimation of grain size distribution, the material is assigned a soil type.
Particle Distribution	ASTM C136, C117, D422, D1140, and C602	Sieve and hydrometer analysis determine grain size distribution, calculated by dry weight of material retained on individual sieves and hydrometer analysis.
Moisture-Density Relationship	ASTM D698	Determines the maximum dry density and optimum moisture content.
Liquid Limit-Plastic Limit	ASTM D4318	Determines the liquid and plastic limit of fine grained soil and the plasticity index
Consolidation	ASTM D2435	Amount soil will consolidate with loading
Direct Shear Test	ASTM D3080	Strength properties of soil resistant to shearing, including angle of internal friction and cohesion

ASTM = American Society for Testing and Materials

MAXIM
TECHNOLOGIES INC

Maxim Technologies Inc.
1610 B Street. P.O. Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF MOISTURE-DENSITY RELATIONS

Unamended
Tailings Composite

CLIENT: MAXIM TECHNOLOGIES, INC.
ATTN: BILL BUCHER
PO BOX 4699
HELENA, MT 59604-4699

PROJECT NO.: 9731701
REPORT NO.: 2261
DATE OF SERVICE: 11/21/97
AUTHORIZATION: MAXIM TECHNOLOGIES, INC.
REPORT DATE: 11/21/97

PROJECT: STREAM SIDE TAILINGS

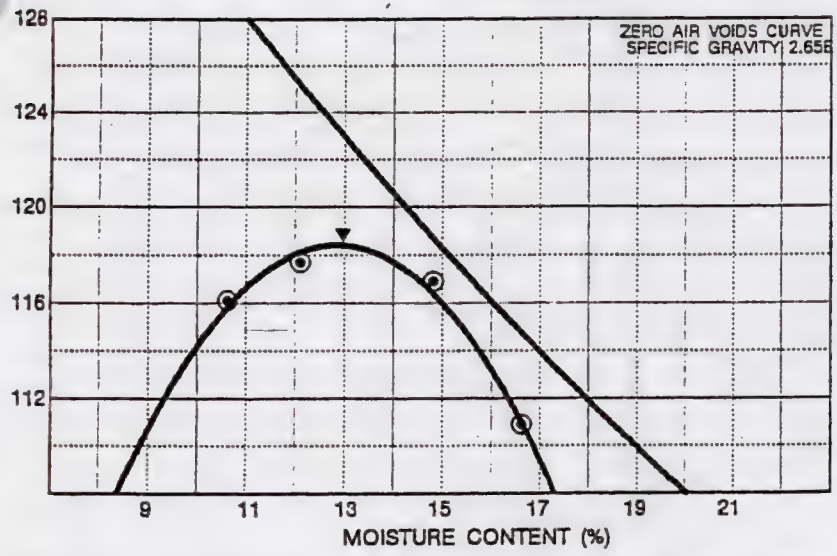
SERVICES: Prepare samples delivered to laboratory and perform moisture-density relations test to establish maximum density and optimum moisture of the material.

PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 11/21/97
SAMPLED BY: Todd Kuxhaus
TEST FOR: Tailings
SAMPLE LOCATION: Various Test Pits
Composite

TEST DATE: 11/21/97
MATERIAL: Tailings ←
CLASSIFICATION: Silty Sand
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: Manual
METHOD OF TEST: ASTM D698-A
ASTM D2488

REPORT OF TESTS



RY
ENS.
cf)

MAXIMUM DENSITY, PCF:	118.5
OPTIMUM MOISTURE (%):	13.0
% PASSING 3/4:	98.0
% PASSING 3/8:	95.0
% PASSING #4:	90.0
% PASSING #40:	59.0
% PASSING #200:	32.0

E - Estimated Value

e: Maximum Density and Optimum Moisture corrected for 10% oversized particles retained No.4 sieve in accordance with ASTM D 4718 procedure using a Specific Gravity of 2.54.

Report Of Tests Continued On Page 2

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MAXIM TECHNOLOGIES, INC.
PROJECT NO. 9731701
DATE OF SERVICE: 11/21/97

REPORT OF TESTS

ADDITIONAL COMMENTS:

SIEVE ANALYSIS

1 1/2" to No. 200
11/06/97
Lab No. 2261-1

Sieve Size	PERCENT PASSING
1 1/2"	100
1"	99
3/4"	98
1/2"	96
3/8"	95
No. 4	90
No. 10	81
No. 20	69
No. 40	59
No. 80	45
No. 200	32

Technician: Steve Whitford
Engineering Technician

Report Distribution:
MAXIM TECHNOLOGIES, INC.

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser, P.E.
Engineering Manager

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MAXIM TECHNOLOGIES INC

Maxim Technologies Inc.
600 South 25th Street - P.O. Box 30615
Billings, MT 59107
Telephone: (406) 248-9161
FAX: (406) 248-9282

REPORT OF GEOTECHNICAL TESTING

Amended Tailings Composite

CLIENT: MT. DEPT. OF ENV. QUALITY
CENTRALIZED SERVICES DIVISION
P.O. BOX 200901
HELENA, MT 596200901

PROJECT: Geotechnical Testing
MT. D.E.Q.

PROJECT NO.: 9731701
REPORT NO.: 1816
DATE OF SERVICE: 2/09/98
AUTHORIZATION: Todd Kuxhaus
REPORT DATE: 2/18/98

SERVICES: Performed Geotechnical Tests as Requested by Client

REPORT OF TESTS

Sample Identification

On February 9, 1998 we received a sample of lime kiln dust and a sample of tailings material with instructions to perform a moisture-density determination, a remolded consolidation test and three remolded direct shear tests prepared from a composite sample of the tailings material and 6.18% of the lime kiln dust added. The test specimens were remolded to 90% of the maximum dry density and optimum moisture content as indicated from the moisture-density determination. The tests were prepared and performed in accordance with the ASTM procedures summerized below.

TEST	STANDARD	FIG. NO.
Moisture-Density Determination	ASTM D698	1
Consolidation Test	ASTM D2435	2
Direct Shear Test	ASTM D3080	3

The test results are included on the attached plates. If you have any questions regarding this report or if we can be of any further service, please contact us.

Technician: George Gartner
Geotechnical Technician

Report Distribution:
MT. DEPT. OF ENV. QUALITY

MAXIM TECHNOLOGIES INC.

George Gartner
Geotechnical Technician

David M. Hummel, Jr. P.E.
Office Manager

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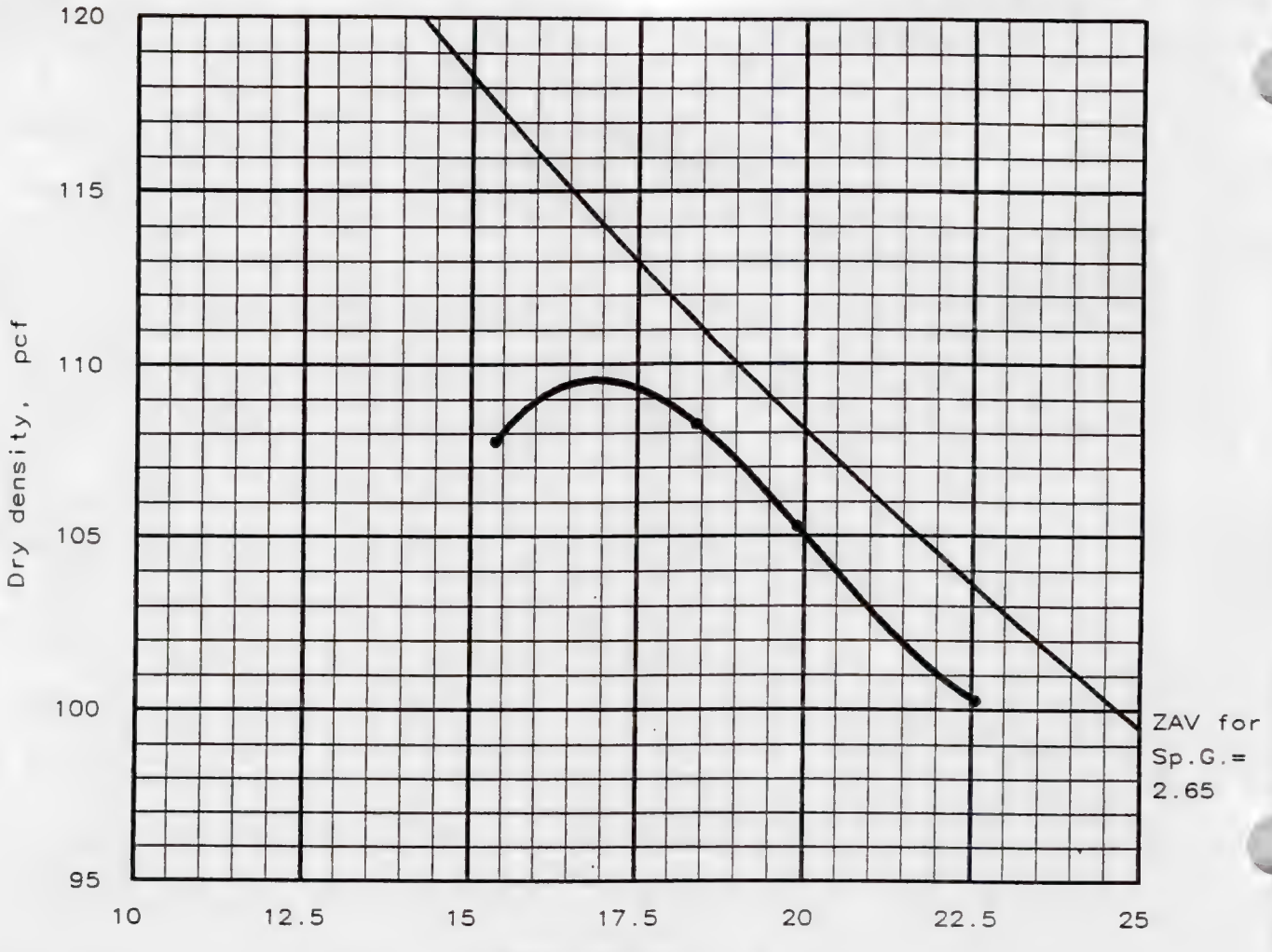
MOISTURE-DENSITY RELATIONSHIP TEST



Test specification: ASTM D 698-91 Procedure A, Standard
Oversize correction applied to each point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > No.4	% < No.200
	USCS	AASHTO						
				2.65			0 %	

ROCK CORRECTED TEST RESULTS	UNCORRECTED	MATERIAL DESCRIPTION
Maximum dry density = 109.6 pcf Optimum moisture = 16.9 %	109.6 pcf 16.9 %	Amended Line Kiln Dust and Tailings Composite

Project No.: 9231701
Project: MT. DEPT. OF ENV. QUALITY
Location:

Date: 2-08-1998

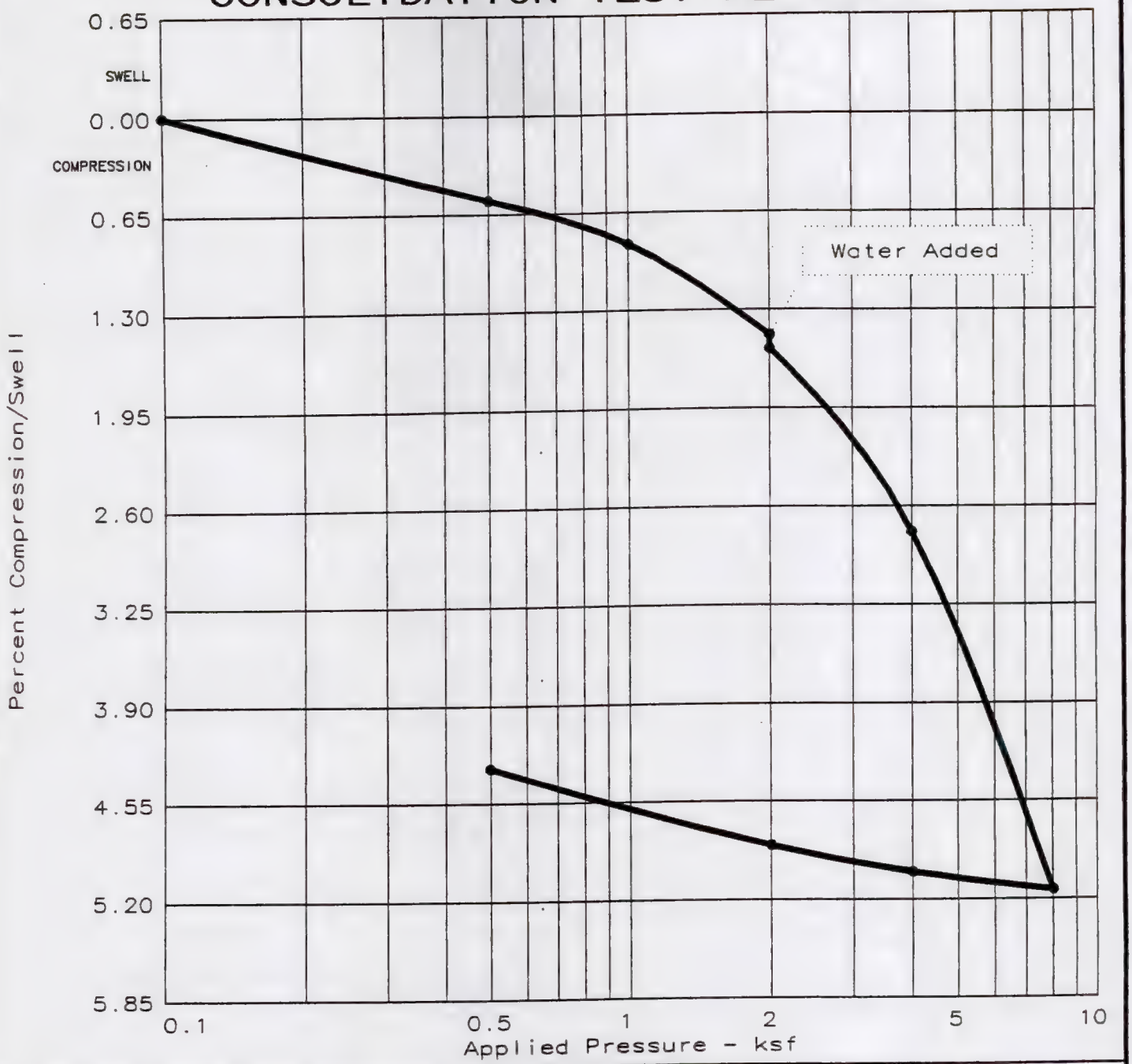
Remarks:

MOISTURE-DENSITY RELATIONSHIP TEST

MAXIM Technologies, Inc.

Fig. No. 1

CONSOLIDATION TEST REPORT



Clpse. %	Na+ Sa	Nat. Moist.	Dry Dens. (pcf)	LL	PI	Sp.Gr.	Initial void ratio
0.1	66.4 %	17.0 %	98.6			2.650	0.6772

TEST RESULTS

MATERIAL DESCRIPTION

Amended Lime Kiln Dust and Tailings Composite

Project No.: 9731701
Project: MT. DEPT. OF ENV. QUALITY
Location:

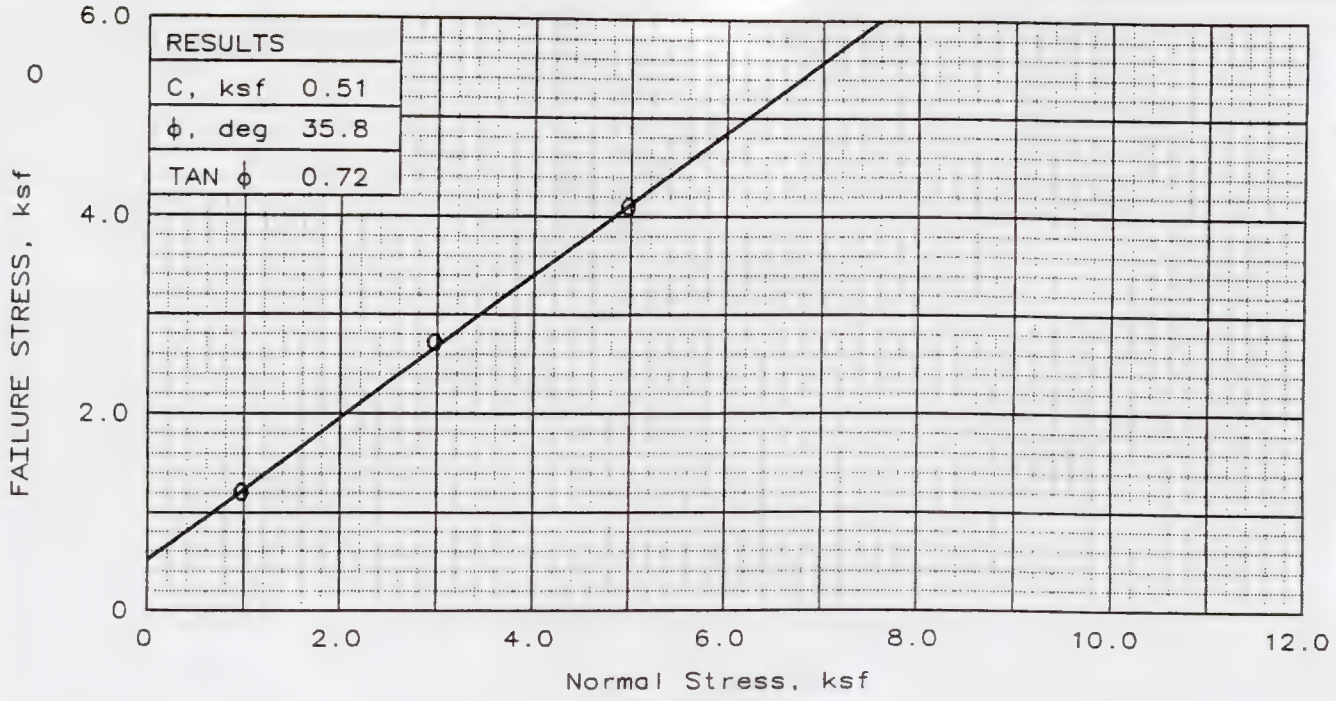
Date: 2-17-98

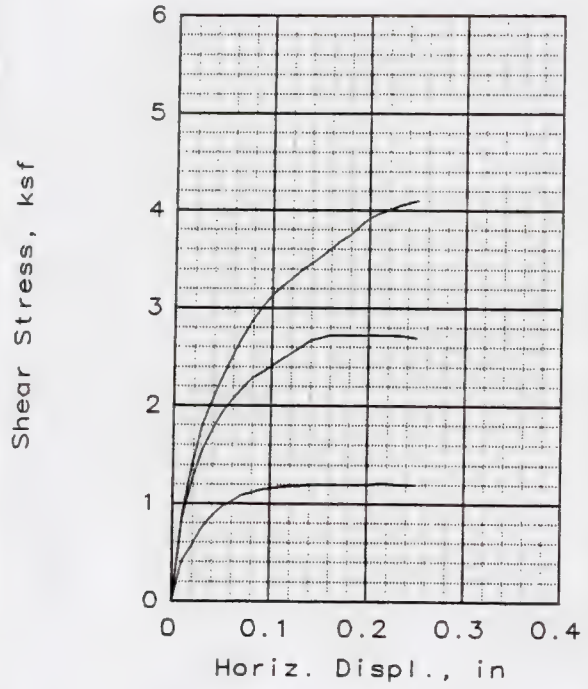
Remarks:

CONSOLIDATION TEST REPORT

MAXIM Technologies, Inc.

Fig. No. 2





SAMPLE NO.:		1	2	3
INITIAL	WATER CONTENT, %	17.0	17.0	17.0
	DRY DENSITY, pcf	98.6	98.6	98.6
	SATURATION, %	66.4	66.4	66.4
	VOID RATIO	0.677	0.677	0.677
	DIAMETER, in	2.40	2.40	2.40
	HEIGHT, in	1.00	1.00	1.00
AT TEST	WATER CONTENT, %	16.8	16.2	15.6
	DRY DENSITY, pcf	100.0	101.0	102.9
	SATURATION, %	68.2	67.3	67.9
	VOID RATIO	0.654	0.639	0.608
	DIAMETER, in	2.40	2.40	2.40
	HEIGHT, in	0.99	0.98	0.96
NORMAL STRESS, ksf		1.00	3.00	5.00
FAILURE STRESS, ksf		1.21	2.72	4.10
DISPLACEMENT, in		0.21	0.16	0.25
RESIDUAL STRESS, ksf				
DISPLACEMENT, in				
Strain rate, in/min		0.0240	0.0240	0.0240

SAMPLE TYPE: Remolded
DESCRIPTION: Amended Lime Kiln Dust and Tailings Composite

ASSUMED SPECIFIC GRAVITY= 2.65
REMARKS: Consolidated Undrained Performed at Optimum Moisture Content

Fig. No.: 3

CLIENT: MT. DEPT. OF ENV. QUALITY

PROJECT:

SAMPLE LOCATION:

PROJ. NO.: 9731701 DATE: 2-17-98

DIRECT SHEAR TEST REPORT

MAXIM Technologies, Inc.

MAXIM TECHNOLOGIES INC

Maxim Technologies
1610 B Street. PO Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF LABORATORY ANALYSIS OF SOILS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: BRIAN GRANT
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2490
DATE OF SERVICE: 2/09/98
AUTHORIZATION: BRIAN GRANT
REPORT DATE: 2/20/98

SERVICES: Perform Moisture Content, Liquid limit-Plastic limit and Sieve Analysis tests in accordance with ASTM D2216, D4318, and C117.

REPORT OF TESTS

REPOSITORY DESIGN

Test results are summarized on the following page:

Report Of Tests Continued On Page 2

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MAXIM

DEPT. ENVIRONMENTAL QUALITY
PROJECT NO. 9731701
DATE OF SERVICE: 2/09/98

REPORT OF TESTS (Continued)

REPOSITORY DESIGN

	MWRR6E-1	~~MWRR2~~-2 (OH-3)	~~MWRR2~~-1 (OH-2)
	14'-15.5'	7.5'-8.6'	5.5'-7.0'
	1/8/98	1/8/98	1/8/98
	LAB NO.	LAB NO.	LAB NO.
	2490-1	2490-2	2490-3
SIEVE ANALYSIS			
Sieve Size		PERCENT PASSING	
1/2"		100	
3/8"	100	99	100
NO. 4	95	96	92
NO. 10	89	78	68
NO. 20	83	54	47
NO. 40	79	37	33
NO. 80	71	24	20
NO. 200	62	17	11
ATTERBERG LIMITS			
Liquid Limit, %	50	32	
Plastic Limit, %	46	26	NON-PLASTIC
Plasticity Index	4	6	
MOISTURE CONTENT (as received), %	47.4	8.9	3.5
CLASSIFICATION ASTM D2487	SANDY ELASTIC SILT (MH)	SANDY SILT (SM)	POORLY GRADED SAND W/SILT (SP-SM)

Technician: Steve Whitford
Engineering Technician

Report Distribution:

(1) GARY FISCHER
(1) CAMERON BEUL
(1) TODD KUXHAUS

MAXIM TECHNOLOGIES INC.

Jeremiah B Bowser

Jeremiah B. Bowser, P.E.
Engineering Manager

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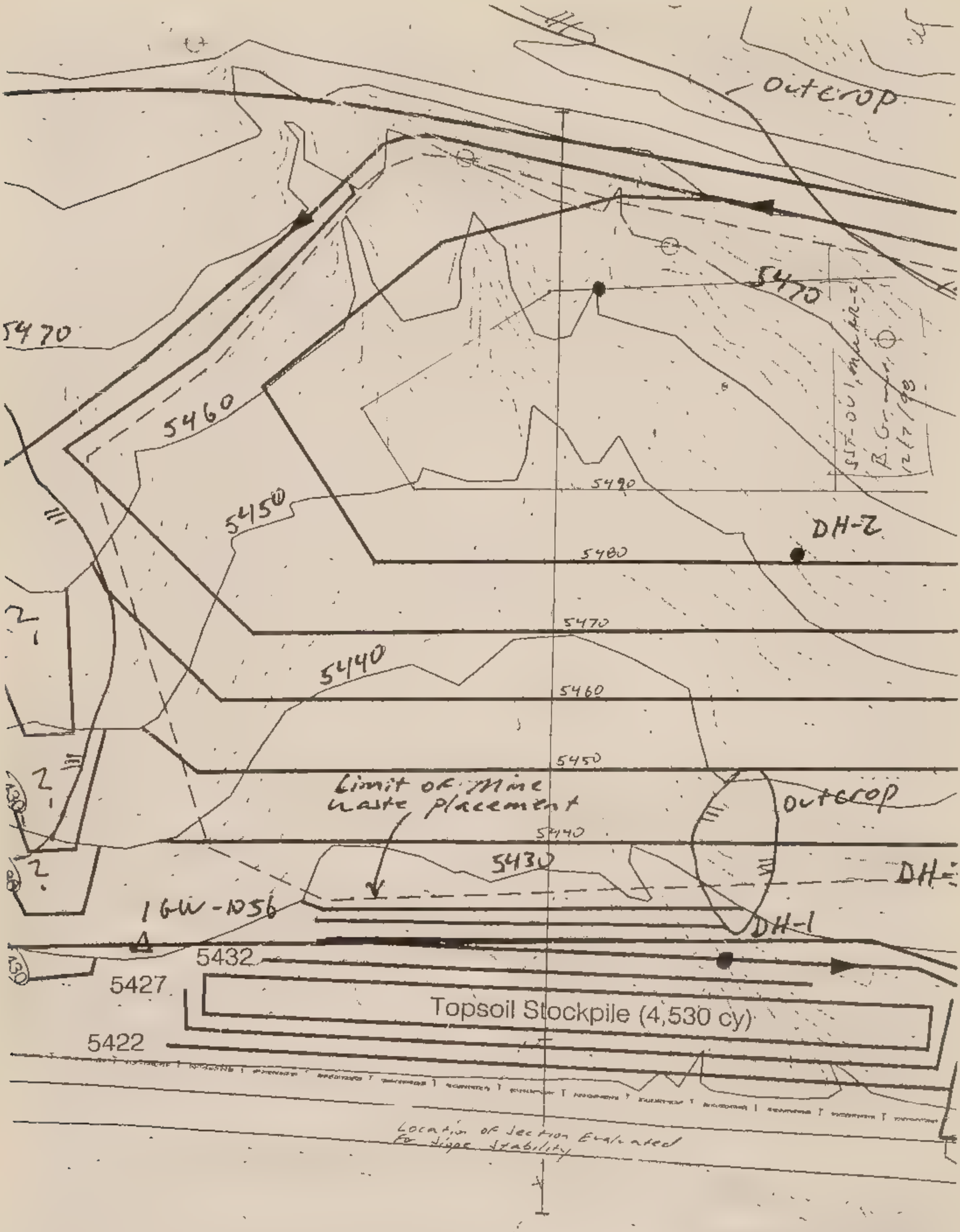
Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 189920
Sample Name: MWRR-2 DH-1 COMPOSITE ←
Sample Date: NONE GIVEN
Collected by: NONE GIVEN
Time Sampled: NONE GIVEN
Sample Type: SOIL

Sieve Size	% Passing
#4	94
#10	77.8
#20	56.9
#40	43.9
#80	32.1
#100	30.0
#200	23.3

ATTACHMENT F

STABL6H COMPUTER MODEL
OUTPUT FILES



Install Culverts Benea
Highway at Locations

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	12/04/98
Time of Run:	2:05pm
Run By:	B. GRANT
Input Data Filename:	C:MWRR2.IN
Output Filename:	C:MWRR2.OUT
Plotted Output Filename:	C:MWRR2.PLT

PROBLEM DESCRIPTION MWRR2-SLOPE STABILITY ANALYSIS
Drained Conditions

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add 00.00 to X values and 5380.00 to Y values listed.

5 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	36.00	165.00	47.00	1
2	165.00	47.00	412.00	110.00	2
3	412.00	110.00	525.00	110.00	2
4	525.00	110.00	590.00	96.00	2
5	590.00	96.00	612.00	100.00	1
6	165.00	47.00	447.00	70.00	1
7	447.00	70.00	590.00	96.00	1
8	.00	16.00	165.00	47.00	3
9	165.00	47.00	447.00	60.00	3
10	447.00	60.00	612.00	90.00	3

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type	Total Unit Wt.	Saturated Unit Wt.	Cohesion Intercept	Friction Angle	Pore Pressure	Pressure Constant	Piez. Surface

Drained

No.	(pcf)	(pcf)	(psf)	(deg)	Param.	(psf)	No.
1	120.4	129.3	.0	35.0	.00	.0	1
2	118.0	124.8	.0	35.8	.00	.0	2
3	165.0	165.0	9999.0	45.0	.00	.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

300 Trial Surfaces Have Been Generated.

30 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 150.00 ft.
and X = 300.00 ft.

Each Surface Terminates Between X = 350.00 ft.
and X = 500.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation. The Angle Has Been Restricted Between The Angles Of -45.0 And 5.0 deg.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	250.00	68.68
2	254.98	69.11
3	259.96	69.61
4	264.92	70.18
5	269.88	70.84
6	274.83	71.56

Drained

7	279.76	72.36
8	284.69	73.23
9	289.60	74.18
10	294.49	75.20
11	299.37	76.29
12	304.23	77.46
13	309.08	78.70
14	313.90	80.01
15	318.71	81.40
16	323.49	82.86
17	328.25	84.38
18	332.99	85.98
19	337.70	87.65
20	342.39	89.39
21	347.05	91.21
22	351.68	93.09
23	356.28	95.04
24	360.31	96.82

Circle Center At X = 224.1 ; Y = 400.7 and Radius, 333.1

*** 2.863 ***

Failure Surface Specified By 49 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	166.67	47.43
2	171.66	47.73
3	176.65	48.08
4	181.63	48.47
5	186.61	48.90
6	191.59	49.37
7	196.56	49.88
8	201.53	50.43
9	206.50	51.02
10	211.46	51.65
11	216.41	52.32
12	221.36	53.03
13	226.31	53.78
14	231.24	54.56
15	236.18	55.39
16	241.10	56.26
17	246.02	57.17
18	250.93	58.12
19	255.83	59.10
20	260.72	60.13
21	265.61	61.20
22	270.48	62.30
23	275.35	63.44
24	280.21	64.63
25	285.06	65.85
26	289.89	67.11

Drained

27	294.72	68.41
28	299.54	69.75
29	304.35	71.13
30	309.14	72.55
31	313.92	74.00
32	318.70	75.50
33	323.45	77.03
34	328.20	78.60
35	332.94	80.21
36	337.66	81.85
37	342.36	83.54
38	347.06	85.26
39	351.74	87.02
40	356.40	88.82
41	361.06	90.65
42	365.69	92.53
43	370.31	94.44
44	374.92	96.38
45	379.51	98.37
46	384.08	100.39
47	388.64	102.45
48	393.18	104.54
49	396.21	105.97

Circle Center At X = 130.8 ; Y = 667.2 and Radius, 620.8

*** 2.872 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	266.67	72.93
2	271.66	73.19
3	276.65	73.55
4	281.63	74.01
5	286.59	74.58
6	291.55	75.25
7	296.49	76.03
8	301.41	76.91
9	306.31	77.89
10	311.19	78.98
11	316.05	80.17
12	320.88	81.46
13	325.68	82.85
14	330.45	84.34
15	335.19	85.94
16	339.90	87.63
17	344.57	89.42
18	349.20	91.31
19	353.78	93.29
20	358.33	95.37

Drained

21 362.43 97.36

Circle Center At X = 257.1 ; Y = 310.6 and Radius, 237.8

*** 2.881 ***

Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.93
2	205.00	56.15
3	209.99	56.42
4	214.98	56.73
5	219.97	57.09
6	224.95	57.50
7	229.93	57.96
8	234.90	58.46
9	239.87	59.01
10	244.84	59.61
11	249.79	60.25
12	254.75	60.94
13	259.69	61.68
14	264.63	62.46
15	269.56	63.29
16	274.48	64.17
17	279.40	65.09
18	284.30	66.06
19	289.20	67.07
20	294.09	68.13
21	298.96	69.24
22	303.83	70.39
23	308.68	71.59
24	313.52	72.83
25	318.36	74.12
26	323.17	75.46
27	327.98	76.84
28	332.77	78.26
29	337.55	79.73
30	342.32	81.25
31	347.07	82.81
32	351.80	84.41
33	356.52	86.06
34	361.23	87.76
35	365.91	89.49
36	370.59	91.28
37	375.24	93.10
38	379.88	94.97
39	384.50	96.88
40	389.10	98.84
41	393.68	100.84
42	398.25	102.88
43	402.79	104.97

Drained

44	407.31	107.10
45	411.82	109.27
46	413.30	110.00

Circle Center At X = 179.0 ; Y = 586.5 and Radius, 531.0

*** 2.882 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	266.67	72.93
2	271.65	73.35
3	276.63	73.82
4	281.60	74.34
5	286.57	74.91
6	291.53	75.54
7	296.48	76.21
8	301.43	76.94
9	306.37	77.71
10	311.30	78.54
11	316.22	79.42
12	321.14	80.35
13	326.04	81.33
14	330.93	82.36
15	335.81	83.44
16	340.68	84.57
17	345.54	85.75
18	350.39	86.98
19	355.22	88.26
20	360.04	89.59
21	364.85	90.97
22	369.64	92.40
23	374.41	93.88
24	379.18	95.41
25	383.92	96.99
26	388.65	98.61
27	393.36	100.29
28	398.05	102.01
29	402.73	103.78
30	407.39	105.60
31	412.02	107.47
32	416.64	109.38
33	418.09	110.00

Circle Center At X = 228.6 ; Y = 556.3 and Radius, 484.8

*** 2.891 ***

Drained

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	216.67	60.18
2	221.67	60.32
3	226.66	60.52
4	231.65	60.78
5	236.64	61.10
6	241.63	61.49
7	246.61	61.94
8	251.58	62.45
9	256.55	63.02
10	261.51	63.65
11	266.46	64.35
12	271.40	65.11
13	276.34	65.92
14	281.26	66.80
15	286.17	67.74
16	291.07	68.74
17	295.95	69.80
18	300.83	70.92
19	305.68	72.11
20	310.53	73.35
21	315.36	74.65
22	320.17	76.01
23	324.96	77.44
24	329.74	78.92
25	334.49	80.46
26	339.23	82.06
27	343.95	83.72
28	348.64	85.43
29	353.32	87.21
30	357.97	89.04
31	362.60	90.93
32	367.20	92.88
33	371.78	94.88
34	376.34	96.94
35	380.87	99.06
36	385.37	101.23
37	389.85	103.46
38	393.27	105.22

Circle Center At X = 208.0 ; Y = 462.9 and Radius, 402.8

*** 2.891 ***

Failure Surface Specified By 29 Coordinate Points

Point	X-Surf	Y-Surf

Drained

No.	(ft)	(ft)
1	283.33	77.18
2	288.33	77.29
3	293.33	77.48
4	298.32	77.76
5	303.31	78.13
6	308.29	78.58
7	313.26	79.12
8	318.22	79.74
9	323.17	80.45
10	328.10	81.25
11	333.03	82.13
12	337.93	83.10
13	342.82	84.15
14	347.69	85.29
15	352.54	86.51
16	357.36	87.81
17	362.17	89.20
18	366.95	90.67
19	371.70	92.23
20	376.42	93.87
21	381.12	95.58
22	385.78	97.38
23	390.41	99.27
24	395.01	101.23
25	399.58	103.27
26	404.11	105.39
27	408.60	107.58
28	413.05	109.86
29	413.32	110.00

Circle Center At X = 279.7 ; Y = 365.3 and Radius, 288.1

*** 2.898 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	300.00	81.43
2	304.99	81.76
3	309.97	82.17
4	314.95	82.64
5	319.92	83.19
6	324.88	83.82
7	329.83	84.52
8	334.77	85.29
9	339.70	86.13
10	344.62	87.05
11	349.52	88.04
12	354.40	89.10
13	359.27	90.24

Drained

14	364.12	91.44
15	368.96	92.72
16	373.77	94.07
17	378.57	95.49
18	383.34	96.98
19	388.09	98.54
20	392.81	100.18
21	397.52	101.88
22	402.19	103.65
23	406.84	105.49
24	411.46	107.40
25	416.05	109.38
26	417.45	110.00

Circle Center At X = 280.2 ; Y = 418.5 and Radius, 337.7

*** 2.906 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	266.67	72.93
2	271.67	72.88
3	276.67	72.96
4	281.66	73.17
5	286.65	73.52
6	291.63	74.00
7	296.59	74.61
8	301.53	75.35
9	306.46	76.22
10	311.36	77.22
11	316.23	78.36
12	321.06	79.62
13	325.87	81.01
14	330.63	82.52
15	335.35	84.17
16	340.03	85.94
17	344.66	87.83
18	349.24	89.84
19	353.76	91.97
20	358.22	94.23
21	362.62	96.60
22	365.15	98.05

Circle Center At X = 271.1 ; Y = 261.1 and Radius, 188.2

*** 2.920 ***

Drained

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	51.68
2	188.33	51.46
3	193.33	51.32
4	198.33	51.25
5	203.33	51.25
6	208.33	51.33
7	213.32	51.48
8	218.32	51.71
9	223.31	52.00
10	228.30	52.37
11	233.28	52.82
12	238.25	53.33
13	243.21	53.92
14	248.17	54.59
15	253.12	55.32
16	258.05	56.13
17	262.97	57.01
18	267.88	57.96
19	272.78	58.98
20	277.66	60.07
21	282.52	61.24
22	287.36	62.48
23	292.19	63.78
24	296.99	65.16
25	301.78	66.61
26	306.54	68.13
27	311.28	69.72
28	316.00	71.38
29	320.69	73.10
30	325.36	74.90
31	330.00	76.76
32	334.61	78.69
33	339.20	80.69
34	343.75	82.76
35	348.27	84.89
36	352.76	87.08
37	357.22	89.35
38	361.65	91.68
39	366.04	94.07
40	370.39	96.53
41	374.71	99.05
42	378.84	101.54

Circle Center At X = 200.5 ; Y = 392.5 and Radius, 341.2

*** 2.938 ***

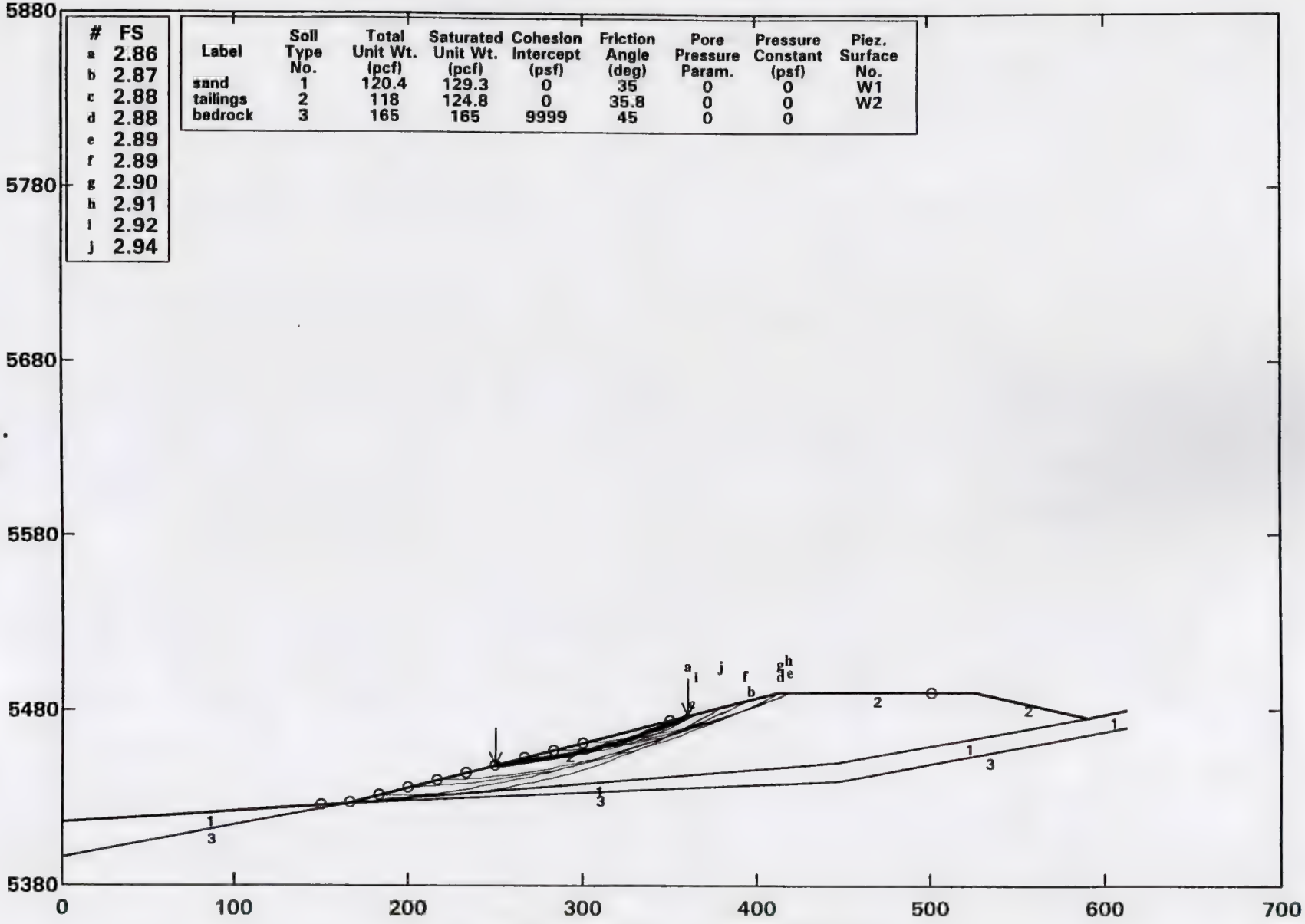
Drained

MWRR2-SLOPE STABILITY ANALYSIS Drained Conditions

Ten Most Critical. C:MWRR2.PLT By: B. GRANT 12/04/98 2:05pm

#	FS
a	2.86
b	2.87
c	2.88
d	2.88
e	2.89
f	2.89
g	2.90
h	2.91
i	2.92
j	2.94

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
sand	1	120.4	129.3	0	35	0	0	W1
tailings	2	118	124.8	0	35.8	0	0	W2
bedrock	3	165	165	9999	45	0	0	



STABL6H FSmin = 2.86 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Drained

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	12/07/98
Time of Run:	10:27am
Run By:	B. GRANT
Input Data Filename:	C:MWRR2SAT.IN
Output Filename:	C:MWRR2SAT.OUT
Plotted Output Filename:	C:MWRR2SAT.PLT

SAT

PROBLEM DESCRIPTION MWRR2-SLOPE STABILITY ANALYSIS
Saturated Soil in Repository Base

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add 00.00 to X values and 5380.00 to Y values listed.

5 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	36.00	165.00	47.00	1
2	165.00	47.00	412.00	110.00	2
3	412.00	110.00	525.00	110.00	2
4	525.00	110.00	590.00	96.00	2
5	590.00	96.00	612.00	100.00	1
6	165.00	47.00	447.00	70.00	1
7	447.00	70.00	590.00	96.00	1
8	.00	16.00	165.00	47.00	3
9	165.00	47.00	447.00	60.00	3
10	447.00	60.00	612.00	90.00	3

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type	Total Unit Wt.	Saturated Unit Wt.	Cohesion Intercept	Friction Angle	Pore Pressure	Pressure Constant	Piez. Surface

SAT

No.	(pcf)	(pcf)	(psf)	(deg)	Param.	(psf)	No.
1	120.4	129.3	.0	35.0	.00	.0	1
2	118.0	124.8	.0	35.8	.00	.0	2
3	165.0	165.0	9999.0	45.0	.00	.0	0

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 7 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	36.00
2	165.00	47.00
3	224.00	62.00
4	447.00	80.00
5	563.00	101.00
6	590.00	96.00
7	612.00	100.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

300 Trial Surfaces Have Been Generated.

30 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 175.00 ft.
and X = 250.00 ft.

Each Surface Terminates Between X = 400.00 ft.
and X = 500.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 20.00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation. The Angle Has Been Restricted Between The Angles Of -45.0 And 5.0 deg.

SAT

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 50 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	191.67	53.80
2	196.64	53.30
3	201.62	52.87
4	206.61	52.50
5	211.60	52.21
6	216.60	51.99
7	221.59	51.84
8	226.59	51.76
9	231.59	51.75
10	236.59	51.82
11	241.59	51.95
12	246.59	52.15
13	251.58	52.43
14	256.57	52.77
15	261.55	53.19
16	266.53	53.68
17	271.50	54.23
18	276.46	54.86
19	281.41	55.56
20	286.35	56.33
21	291.28	57.17
22	296.19	58.07
23	301.10	59.05
24	305.99	60.10
25	310.86	61.21
26	315.72	62.40
27	320.56	63.65
28	325.38	64.97
29	330.18	66.36
30	334.97	67.82
31	339.73	69.35
32	344.47	70.94
33	349.18	72.60
34	353.88	74.33
35	358.54	76.12
36	363.19	77.98
37	367.80	79.90
38	372.39	81.89
39	376.95	83.95
40	381.47	86.07
41	385.97	88.25

SAT

42	390.44	90.50
43	394.87	92.80
44	399.28	95.18
45	403.64	97.61
46	407.98	100.11
47	412.27	102.66
48	416.53	105.28
49	420.76	107.96
50	423.88	110.00

Circle Center At X = 229.7 ; Y = 404.6 and Radius, 352.9

*** 2.644 ***

Failure Surface Specified By 51 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	51.68
2	188.33	51.41
3	193.32	51.20
4	198.32	51.06
5	203.32	50.97
6	208.32	50.95
7	213.32	50.98
8	218.32	51.08
9	223.32	51.24
10	228.31	51.46
11	233.30	51.74
12	238.29	52.09
13	243.27	52.49
14	248.25	52.95
15	253.23	53.48
16	258.19	54.07
17	263.15	54.71
18	268.10	55.42
19	273.04	56.19
20	277.97	57.01
21	282.89	57.90
22	287.80	58.85
23	292.70	59.86
24	297.58	60.93
25	302.45	62.05
26	307.31	63.24
27	312.15	64.49
28	316.98	65.79
29	321.79	67.16
30	326.58	68.58
31	331.36	70.06
32	336.12	71.60
33	340.85	73.20
34	345.57	74.85
35	350.27	76.56

SAT

36	354.95	78.33
37	359.60	80.16
38	364.23	82.05
39	368.84	83.99
40	373.42	85.98
41	377.98	88.04
42	382.52	90.14
43	387.02	92.31
44	391.51	94.52
45	395.96	96.80
46	400.38	99.12
47	404.78	101.50
48	409.15	103.94
49	413.49	106.43
50	417.79	108.97
51	419.50	110.00

Circle Center At X = 207.8 ; Y = 460.1 and Radius, 409.1

*** 2.652 ***

Failure Surface Specified By 55 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	175.00	49.55
2	180.00	49.47
3	185.00	49.43
4	190.00	49.45
5	195.00	49.51
6	200.00	49.61
7	205.00	49.77
8	209.99	49.97
9	214.99	50.22
10	219.98	50.52
11	224.96	50.86
12	229.95	51.25
13	234.93	51.69
14	239.91	52.18
15	244.88	52.71
16	249.84	53.29
17	254.80	53.92
18	259.76	54.59
19	264.71	55.31
20	269.65	56.08
21	274.58	56.90
22	279.51	57.76
23	284.42	58.67
24	289.33	59.62
25	294.23	60.63
26	299.12	61.67
27	304.00	62.77

SAT

28	308.86	63.91
29	313.72	65.10
30	318.57	66.33
31	323.40	67.61
32	328.22	68.93
33	333.03	70.30
34	337.83	71.72
35	342.61	73.18
36	347.37	74.69
37	352.13	76.24
38	356.87	77.84
39	361.59	79.48
40	366.30	81.17
41	370.99	82.90
42	375.66	84.67
43	380.32	86.49
44	384.96	88.36
45	389.58	90.27
46	394.18	92.22
47	398.77	94.21
48	403.33	96.25
49	407.88	98.34
50	412.40	100.46
51	416.91	102.63
52	421.39	104.84
53	425.86	107.09
54	430.30	109.39
55	431.46	110.00

Circle Center At X = 186.2 ; Y = 576.3 and Radius, 526.9

*** 2.672 ***

Failure Surface Specified By 57 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	51.68
2	188.32	51.32
3	193.31	51.02
4	198.31	50.78
5	203.30	50.58
6	208.30	50.44
7	213.30	50.35
8	218.30	50.31
9	223.30	50.33
10	228.30	50.40
11	233.30	50.53
12	238.29	50.70
13	243.29	50.93
14	248.28	51.21
15	253.27	51.55
16	258.25	51.94

SAT

17	263.24	52.38
18	268.21	52.87
19	273.18	53.42
20	278.15	54.02
21	283.10	54.67
22	288.05	55.37
23	293.00	56.13
24	297.93	56.94
25	302.85	57.80
26	307.77	58.71
27	312.68	59.67
28	317.57	60.69
29	322.46	61.76
30	327.33	62.88
31	332.19	64.05
32	337.04	65.28
33	341.87	66.55
34	346.69	67.88
35	351.50	69.25
36	356.29	70.68
37	361.07	72.16
38	365.83	73.69
39	370.57	75.27
40	375.30	76.90
41	380.01	78.58
42	384.70	80.31
43	389.37	82.09
44	394.03	83.92
45	398.66	85.79
46	403.27	87.72
47	407.87	89.70
48	412.44	91.72
49	416.99	93.79
50	421.52	95.91
51	426.02	98.08
52	430.51	100.30
53	434.96	102.56
54	439.40	104.87
55	443.81	107.23
56	448.19	109.63
57	448.85	110.00

Circle Center At X = 219.2 ; Y = 522.1 and Radius, 471.8

*** 2.716 ***

Failure Surface Specified By 41 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	225.00	62.30
2	229.75	60.73

SAT

3	234.54	59.29
4	239.37	58.00
5	244.23	56.85
6	249.13	55.84
7	254.05	54.98
8	259.00	54.27
9	263.97	53.70
10	268.95	53.27
11	273.94	52.99
12	278.94	52.86
13	283.94	52.88
14	288.94	53.04
15	293.93	53.36
16	298.91	53.81
17	303.87	54.42
18	308.82	55.17
19	313.74	56.06
20	318.63	57.10
21	323.48	58.29
22	328.30	59.61
23	333.08	61.08
24	337.82	62.69
25	342.50	64.43
26	347.14	66.31
27	351.71	68.33
28	356.22	70.48
29	360.67	72.77
30	365.05	75.18
31	369.36	77.72
32	373.59	80.39
33	377.73	83.18
34	381.80	86.09
35	385.78	89.13
36	389.66	92.27
37	393.45	95.53
38	397.15	98.90
39	400.74	102.38
40	404.23	105.96
41	406.71	108.65

Circle Center At X = 280.9 ; Y = 222.7 and Radius, 169.8

*** 2.769 ***

Failure Surface Specified By 47 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	51.68
2	188.33	51.93
3	193.32	52.23
4	198.31	52.58
5	203.29	52.97

SAT

6	208.27	53.40
7	213.25	53.88
8	218.22	54.40
9	223.19	54.97
10	228.15	55.58
11	233.11	56.23
12	238.06	56.93
13	243.01	57.67
14	247.94	58.46
15	252.87	59.28
16	257.80	60.16
17	262.71	61.07
18	267.62	62.03
19	272.52	63.04
20	277.41	64.09
21	282.29	65.18
22	287.16	66.31
23	292.02	67.49
24	296.86	68.71
25	301.70	69.97
26	306.53	71.27
27	311.34	72.62
28	316.15	74.01
29	320.94	75.45
30	325.71	76.92
31	330.48	78.44
32	335.23	80.00
33	339.96	81.61
34	344.69	83.25
35	349.39	84.94
36	354.08	86.66
37	358.76	88.43
38	363.42	90.24
39	368.07	92.10
40	372.69	93.99
41	377.30	95.93
42	381.90	97.90
43	386.47	99.92
44	391.03	101.97
45	395.57	104.07
46	400.09	106.21
47	403.40	107.81

Circle Center At X = 156.9 ; Y = 614.8 and Radius, 563.7

*** 2.878 ***

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	241.67	66.55

SAT

2	246.66	66.78
3	251.65	67.07
4	256.64	67.42
5	261.62	67.83
6	266.60	68.30
7	271.57	68.82
8	276.54	69.41
9	281.50	70.06
10	286.45	70.77
11	291.39	71.54
12	296.32	72.37
13	301.24	73.26
14	306.15	74.21
15	311.05	75.21
16	315.93	76.28
17	320.80	77.41
18	325.66	78.59
19	330.50	79.84
20	335.33	81.14
21	340.14	82.50
22	344.94	83.92
23	349.71	85.39
24	354.47	86.93
25	359.21	88.52
26	363.93	90.17
27	368.63	91.87
28	373.31	93.64
29	377.97	95.45
30	382.60	97.33
31	387.22	99.26
32	391.80	101.25
33	396.37	103.29
34	400.91	105.39
35	405.42	107.54
36	408.72	109.16

Circle Center At X = 225.4 ; Y = 479.2 and Radius, 413.0

*** 2.881 ***

Failure Surface Specified By 43 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	233.33	64.43
2	238.09	62.87
3	242.88	61.45
4	247.71	60.15
5	252.57	59.00
6	257.47	57.97
7	262.39	57.09
8	267.33	56.34
9	272.29	55.72

SAT

10	277.27	55.25
11	282.26	54.91
12	287.25	54.71
13	292.25	54.65
14	297.25	54.73
15	302.25	54.94
16	307.24	55.29
17	312.21	55.78
18	317.17	56.41
19	322.11	57.18
20	327.03	58.08
21	331.92	59.12
22	336.78	60.29
23	341.61	61.60
24	346.40	63.04
25	351.14	64.61
26	355.84	66.31
27	360.50	68.15
28	365.10	70.11
29	369.64	72.19
30	374.13	74.40
31	378.55	76.74
32	382.90	79.20
33	387.19	81.77
34	391.40	84.46
35	395.54	87.27
36	399.59	90.20
37	403.57	93.23
38	407.46	96.37
39	411.26	99.62
40	414.97	102.97
41	418.58	106.43
42	422.10	109.98
43	422.12	110.00

Circle Center At X = 292.0 ; Y = 235.3 and Radius, 180.7

*** 2.886 ***

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	241.67	66.55
2	246.67	66.59
3	251.67	66.69
4	256.66	66.87
5	261.66	67.13
6	266.65	67.45
7	271.63	67.85
8	276.61	68.33
9	281.58	68.88

SAT

10	286.54	69.50
11	291.49	70.19
12	296.43	70.96
13	301.36	71.80
14	306.28	72.71
15	311.18	73.69
16	316.06	74.75
17	320.94	75.88
18	325.79	77.08
19	330.62	78.35
20	335.44	79.70
21	340.24	81.11
22	345.01	82.60
23	349.76	84.15
24	354.49	85.78
25	359.20	87.47
26	363.87	89.24
27	368.53	91.07
28	373.15	92.97
29	377.75	94.94
30	382.31	96.98
31	386.85	99.08
32	391.35	101.25
33	395.82	103.49
34	400.26	105.79
35	404.57	108.10

Circle Center At X = 242.0 ; Y = 405.5 and Radius, 338.9

*** 2.904 ***

Failure Surface Specified By 48 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	216.67	60.18
2	221.58	59.25
3	226.51	58.42
4	231.45	57.67
5	236.41	57.01
6	241.38	56.43
7	246.35	55.95
8	251.34	55.56
9	256.33	55.25
10	261.32	55.03
11	266.32	54.90
12	271.32	54.86
13	276.32	54.91
14	281.32	55.05
15	286.31	55.28
16	291.30	55.60
17	296.29	56.00
18	301.26	56.50

JAT

19	306.23	57.08
20	311.18	57.75
21	316.13	58.51
22	321.05	59.36
23	325.97	60.29
24	330.86	61.31
25	335.74	62.42
26	340.59	63.62
27	345.42	64.90
28	350.23	66.27
29	355.02	67.72
30	359.78	69.26
31	364.50	70.88
32	369.20	72.59
33	373.87	74.37
34	378.51	76.25
35	383.11	78.20
36	387.68	80.24
37	392.21	82.36
38	396.70	84.55
39	401.15	86.83
40	405.56	89.19
41	409.93	91.62
42	414.25	94.13
43	418.53	96.72
44	422.76	99.39
45	426.94	102.13
46	431.08	104.94
47	435.16	107.83
48	438.12	110.00

Circle Center At X = 271.0 ; Y = 335.6 and Radius, 280.8

*** 2.915 ***

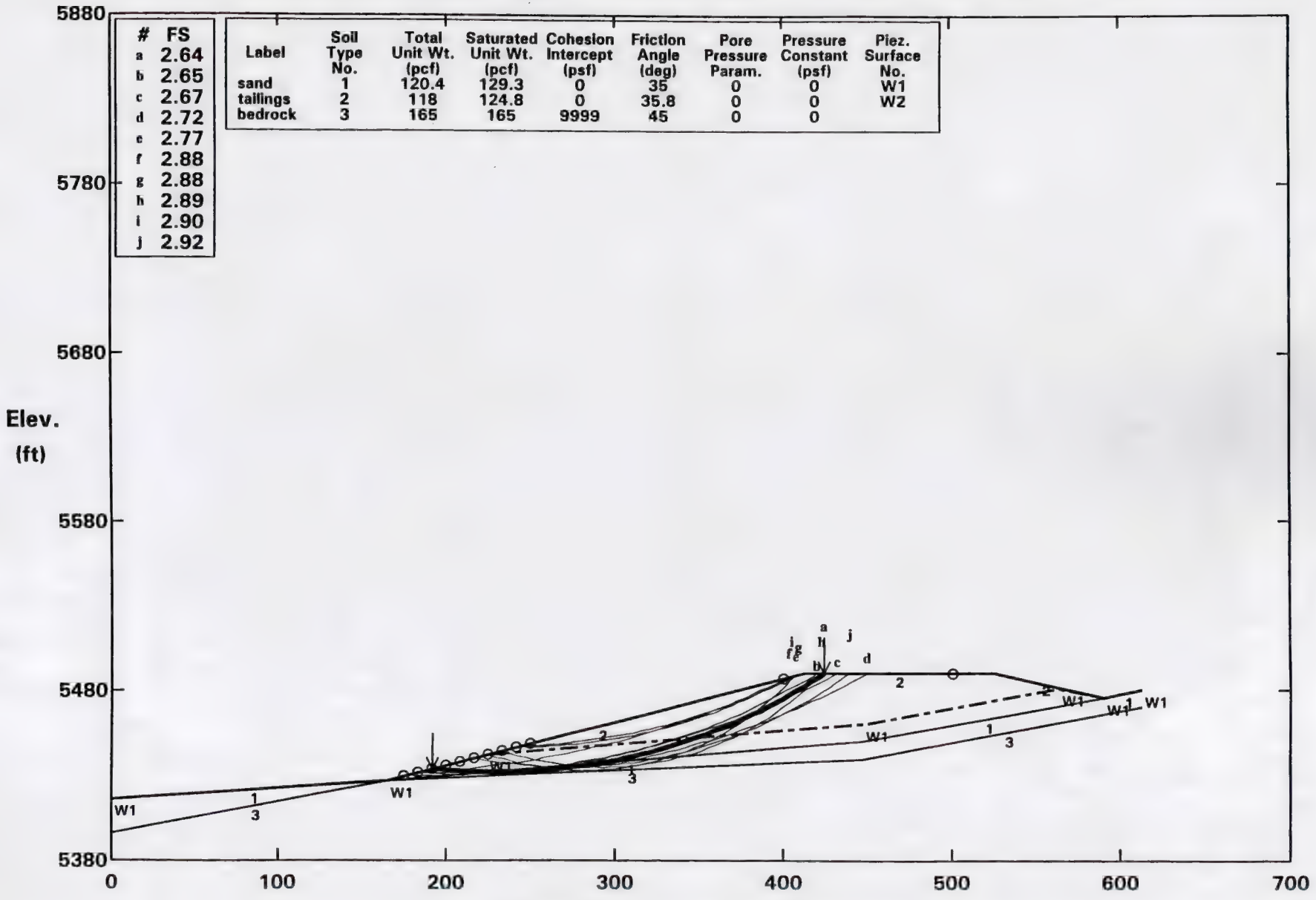
SAT

MWRR2-SLOPE STABILITY ANALYSIS Saturated Soil in Repository Base

Ten Most Critical. C:MWRR2SAT.PLT By: B. GRANT 12/07/98 10:27am

#	FS
a	2.64
b	2.65
c	2.67
d	2.72
e	2.77
f	2.88
g	2.88
h	2.89
i	2.90
j	2.92

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
sand	1	120.4	129.3	0	35	0	0	W1
tailings	2	118	124.8	0	35.8	0	0	W2
bedrock	3	165	165	9999	45	0	0	



STABL6H FSmin = 2.64 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

S47

** STABL6H **
by
Purdue University

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer`s Method of Slices

Run Date:	12/07/98
Time of Run:	3:12pm
Run By:	B. GRANT
Input Data Filename:	C:MWRR2SAT.IN
Output Filename:	C:MWRR2SAT.OUT
Plotted Output Filename:	C:MWRR2SAT.PLT

PROBLEM DESCRIPTION MWRR2-SLOPE STABILITY ANALYSIS
Saturated Soil in Repository Base

BOUNDARY COORDINATES
NOTE: User defined origin was specified.
Add 00.00 to X values and 5380.00 to Y values listed.

5 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	36.00	165.00	47.00	1
2	165.00	47.00	412.00	110.00	2
3	412.00	110.00	525.00	110.00	2
4	525.00	110.00	590.00	96.00	2
5	590.00	96.00	612.00	100.00	1
6	165.00	47.00	447.00	70.00	1
7	447.00	70.00	590.00	96.00	1
8	.00	16.00	165.00	47.00	3
9	165.00	47.00	447.00	60.00	3
10	447.00	60.00	612.00	90.00	3

ISOTROPIC SOIL PARAMETERS

3 Type(s) of Soil

Soil Type	Total Unit Wt.	Saturated Unit Wt.	Cohesion Intercept	Friction Angle	Pore Pressure	Pressure Constant	Piez. Surface

EW

No.	(pcf)	(pcf)	(psf)	(deg)	Param.	(psf)	No.
1	120.4	129.3	.0	35.0	.00	.0	1
2	118.0	124.8	.0	35.8	.00	.0	2
3	165.0	165.0	9999.0	45.0	.00	.0	0

---

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 7 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	36.00
2	165.00	47.00
3	224.00	62.00
4	447.00	80.00
5	563.00	101.00
6	590.00	96.00
7	612.00	100.00

A Horizontal Earthquake Loading Coefficient
Of .100 Has Been Assigned

A Vertical Earthquake Loading Coefficient
Of .000 Has Been Assigned

Cavitation Pressure = .0 psf

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.

300 Trial Surfaces Have Been Generated.

30 Surfaces Initiate From Each Of 10 Points Equally Spaced
Along The Ground Surface Between X = 175.00 ft.
and X = 250.00 ft.

Each Surface Terminates Between X = 400.00 ft.
and X = 500.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation

At Which A Surface Extends Is Y = 20.00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

Restrictions Have Been Imposed Upon The Angle Of Initiation.
The Angle Has Been Restricted Between The Angles Of -45.0
And 5.0 deg.

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Bishop Method * *

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	191.67	53.80
2	201.62	52.79
3	211.59	52.08
4	221.58	51.65
5	231.58	51.51
6	241.58	51.66
7	251.57	52.10
8	261.54	52.82
9	271.49	53.84
10	281.41	55.14
11	291.28	56.73
12	301.10	58.61
13	310.87	60.77
14	320.56	63.21
15	330.19	65.93
16	339.73	68.92
17	349.18	72.20
18	358.53	75.74
19	367.77	79.55
20	376.90	83.63
21	385.91	87.98
22	394.79	92.58
23	403.53	97.43
24	412.13	102.54
25	420.57	107.89
26	423.69	110.00

Circle Center At X = 231.4 ; Y = 397.0 and Radius, 345.5

*** 1.819 ***

EO

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	175.00	49.55
2	185.00	49.39
3	195.00	49.41
4	205.00	49.64
5	214.99	50.05
6	224.97	50.66
7	234.94	51.46
8	244.89	52.46
9	254.82	53.65
10	264.72	55.02
11	274.60	56.60
12	284.44	58.36
13	294.25	60.31
14	304.02	62.45
15	313.74	64.78
16	323.42	67.30
17	333.05	70.00
18	342.62	72.89
19	352.13	75.97
20	361.59	79.23
21	370.98	82.67
22	380.30	86.29
23	389.55	90.10
24	398.72	94.08
25	407.82	98.23
26	416.83	102.57
27	425.76	107.07
28	431.28	110.00

Circle Center At X = 188.5 ; Y = 565.9 and Radius, 516.5

*** 1.833 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	216.67	60.18
2	226.49	58.33
3	236.38	56.84
4	246.32	55.71
5	256.29	54.94
6	266.28	54.54

7	276.28	54.50
8	286.28	54.83
9	296.25	55.51
10	306.20	56.57
11	316.10	57.98
12	325.94	59.75
13	335.71	61.88
14	345.40	64.36
15	354.99	67.20
16	364.47	70.38
17	373.83	73.90
18	383.05	77.76
19	392.13	81.96
20	401.05	86.48
21	409.79	91.33
22	418.36	96.49
23	426.73	101.96
24	434.90	107.72
25	437.88	110.00

Circle Center At X = 272.4 ; Y = 329.2 and Radius, 274.7

*** 1.992 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	233.33	64.43
2	242.84	61.31
3	252.50	58.74
4	262.29	56.72
5	272.19	55.26
6	282.15	54.36
7	292.14	54.03
8	302.14	54.26
9	312.11	55.06
10	322.01	56.42
11	331.83	58.34
12	341.52	60.82
13	351.05	63.84
14	360.40	67.39
15	369.53	71.47
16	378.41	76.06
17	387.02	81.14
18	395.33	86.70
19	403.31	92.73
20	410.94	99.20
21	418.19	106.09
22	421.86	110.00

Circle Center At X = 293.0 ; Y = 230.5 and Radius, 176.5

EO

*** 2.003 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	241.67	66.55
2	251.66	67.01
3	261.63	67.71
4	271.59	68.67
5	281.51	69.87
6	291.41	71.32
7	301.26	73.01
8	311.07	74.95
9	320.83	77.14
10	330.53	79.57
11	340.17	82.24
12	349.74	85.15
13	359.23	88.29
14	368.64	91.68
15	377.96	95.30
16	387.19	99.14
17	396.32	103.22
18	405.35	107.53
19	408.41	109.08

Circle Center At X = 228.5 ; Y = 466.7 and Radius, 400.4

*** 2.021 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	233.33	64.43
2	242.91	61.56
3	252.63	59.19
4	262.45	57.33
5	272.36	55.99
6	282.33	55.16
7	292.32	54.86
8	302.32	55.07
9	312.30	55.80
10	322.22	57.05
11	332.06	58.82
12	341.80	61.10
13	351.40	63.88

14	360.85	67.15
15	370.12	70.92
16	379.17	75.16
17	387.99	79.87
18	396.56	85.02
19	404.85	90.62
20	412.83	96.64
21	420.49	103.07
22	427.80	109.89
23	427.91	110.00

Circle Center At X = 293.2 ; Y = 246.9 and Radius, 192.1

*** 2.028 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	51.68
2	193.30	52.47
3	203.26	53.39
4	213.20	54.44
5	223.13	55.62
6	233.05	56.93
7	242.94	58.37
8	252.82	59.94
9	262.68	61.64
10	272.51	63.46
11	282.31	65.42
12	292.09	67.50
13	301.85	69.71
14	311.57	72.05
15	321.26	74.52
16	330.92	77.11
17	340.54	79.83
18	350.13	82.67
19	359.68	85.64
20	369.19	88.73
21	378.66	91.95
22	388.08	95.29
23	397.46	98.76
24	406.80	102.35
25	416.08	106.05
26	425.32	109.88
27	425.59	110.00

Circle Center At X = 127.9 ; Y = 814.1 and Radius, 764.5

*** 2.033 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	241.67	66.55
2	251.67	66.62
3	261.66	66.99
4	271.64	67.66
5	281.59	68.64
6	291.51	69.92
7	301.38	71.49
8	311.20	73.37
9	320.96	75.55
10	330.65	78.02
11	340.26	80.79
12	349.78	83.85
13	359.21	87.19
14	368.53	90.83
15	377.73	94.74
16	386.81	98.93
17	395.75	103.40
18	404.46	108.08

Circle Center At X = 244.5 ; Y = 395.2 and Radius, 328.6

*** 2.039 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	51.68
2	193.31	52.29
3	203.29	53.05
4	213.24	53.96
5	223.19	55.00
6	233.12	56.19
7	243.03	57.52
8	252.92	58.99
9	262.79	60.60
10	272.64	62.36
11	282.45	64.25
12	292.25	66.29
13	302.01	68.46
14	311.73	70.78
15	321.43	73.23
16	331.09	75.82
17	340.71	78.55

E0

18	350.29	81.42
19	359.83	84.42
20	369.32	87.56
21	378.77	90.84
22	388.17	94.25
23	397.52	97.79
24	406.82	101.47
25	416.06	105.28
26	425.25	109.23
27	426.99	110.00

Circle Center At X = 145.2 ; Y = 749.3 and Radius, 698.6

*** 2.042 ***

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	175.00	49.55
2	185.00	49.66
3	195.00	49.96
4	204.98	50.44
5	214.96	51.11
6	224.93	51.96
7	234.87	52.99
8	244.80	54.21
9	254.70	55.61
10	264.57	57.19
11	274.42	58.95
12	284.23	60.90
13	294.00	63.02
14	303.73	65.33
15	313.41	67.81
16	323.05	70.47
17	332.64	73.31
18	342.18	76.33
19	351.65	79.52
20	361.07	82.88
21	370.42	86.42
22	379.71	90.13
23	388.93	94.01
24	398.07	98.06
25	407.14	102.28
26	416.13	106.66
27	422.66	110.00

Circle Center At X = 173.9 ; Y = 592.0 and Radius, 542.4

*** 2.047 ***

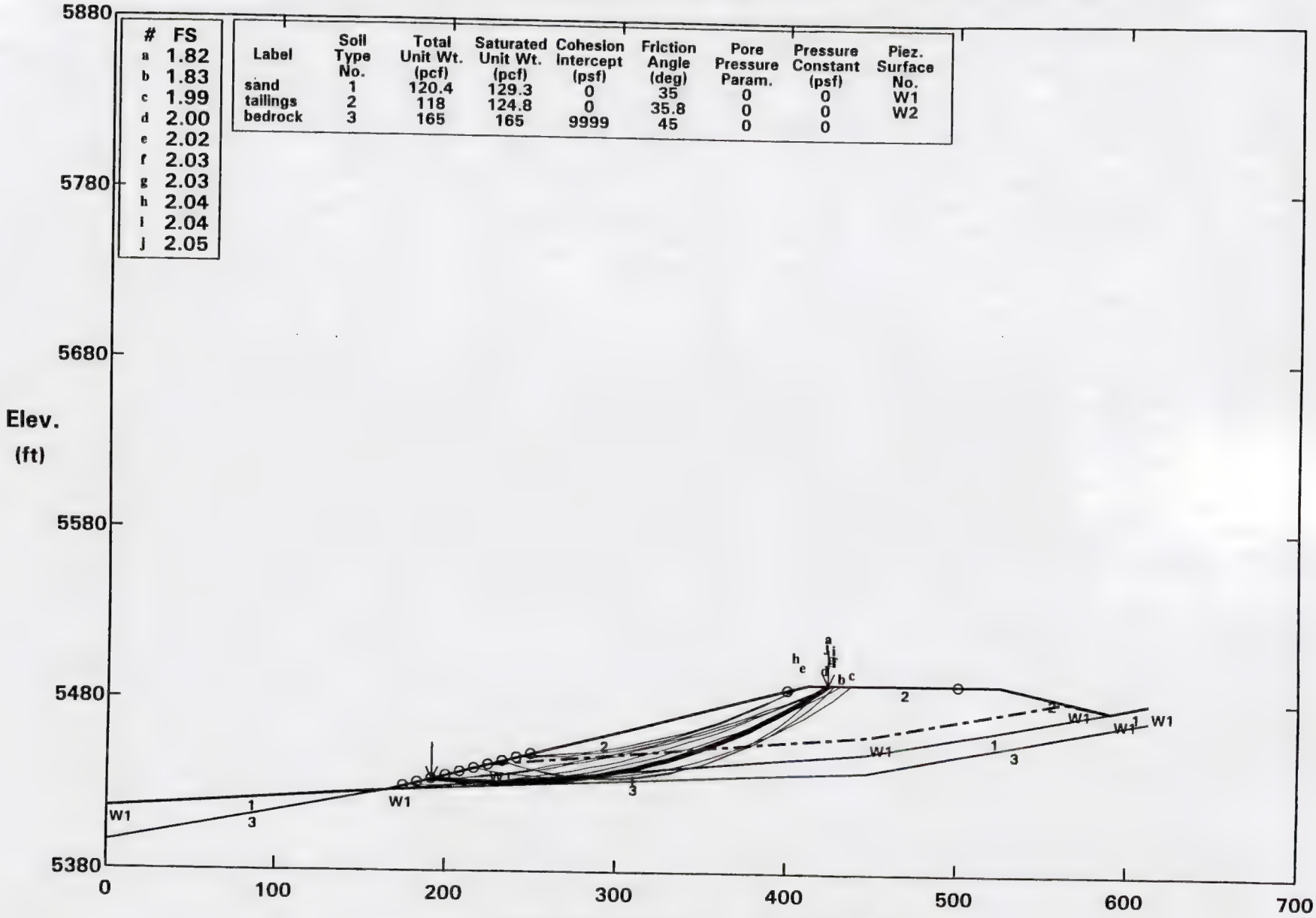
EQ

MWRR2-SLOPE STABILITY ANALYSIS Saturated Soil in Repository Base

Ten Most Critical. C:MWRR2SAT.PLT By: B. GRANT 12/07/98 3:12pm

#	FS
a	1.82
b	1.83
c	1.99
d	2.00
e	2.02
f	2.03
g	2.03
h	2.04
i	2.04
j	2.05

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
sand	1	120.4	129.3	0	35	0	0	W1
tailings	2	118	124.8	0	35.8	0	0	W2
bedrock	3	165	165	9999	45	0	0	



STABL6H FSmin = 1.82 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

APPENDIX F-5

Groundwater Quality

MAXIM TECHNOLOGIES INC

BY BRG DATE 3/2/98

JOB TITLE SST-Out-MWRR-2 JOB NUMBER

SUBJECT Arsenic Concentration in Groundwater SHEET 1/2

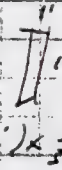
Purpose: Calculate an estimate of Arsenic Concentration in Groundwater at the toe of repository MWRR-2

See "Alternative Analysis for Mine Waste Relocation Repositories" (Maxim, 1998) for additional information and description for parameters / methods described below.

Calculation:

Estimate existing conditions of Groundwater

- Information obtained wells located near confluence with Whiskey Gulch
  - Soil Type of Medium Sand
  - hydraulic conductivity $\Rightarrow 1 \times 10^{-2}$ cm/sec
  - Groundwater Gradient $\Rightarrow$ 0.01 Ft/Ft
- For purpose of calculation, estimate Groundwater aquifer is 10 feet thick, width of 1 foot



- Determine Flow rate

$$Q = k \cdot i \cdot A$$

$$= 1 \times 10^{-2} \text{ cm/sec} \times 0.01 \text{ Ft/Ft} \times (1' \times 10') \times \frac{1 \text{ Ft}}{30.48 \text{ cm}} \times \frac{86,400 \text{ sec}}{\text{day}}$$

$$= 2.83 \text{ Ft}^3/\text{day}$$

- Concentration of Background Arsenic in Groundwater

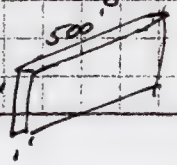
$C_{BG} = 0.011$ mg/L (Well C-15, Whiskey Gulch)

Estimate Leachate Characteristics

- Percolation Rate determined using HELP, Version 3.05 (attached)

~~Percent~~ Perc = ~~0.0075~~ 0.74 in/year

- Area through which Percolation Flux occurs is 500 feet (Longest length across repository in downgradient direction)



MAXIM TECHNOLOGIES INC

BY BRG DATE 8/3/98

JOB TITLE SST-OU1-MWRR-2 JOB NUMBER

SUBJECT Arsenic Concentration in Groundwater SHEET 2/2

Leachate Flowrate

$Q_{leach} = Perc \times Area$

$= 0.74 \text{ in/year} \times (500' \times 1') \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ year}}{365 \text{ days}}$

$= 0.085 \text{ ft}^3/\text{day}$

Concentration of Arsenic in Groundwater - from Maxim, 1998

$C_{leach} = 0.210 \text{ mg/L}$

This assumes no attenuation. Sorption testing (Maxim, 1998) has shown substantial reductions in Arsenic concentration in native soil beneath repository.

Calculate resulting arsenic concentration in groundwater following its mixing with leachate.

A mixing depth of 10 feet is used

$$C_{AS} = \frac{Q_{GW} \times C_{GW} + Q_{leach} \times C_{leach}}{Q_{GW} + Q_{leach}}$$

$$= \frac{(2.93)(0.011) + (0.085)(.210)}{2.93 + 0.085}$$

$= 0.017 \text{ mg/L}$ - again this assumes no attenuation of Arsenic in subsurface.

For Comparison

0.011 mg/L Background AS concentration

0.018 mg/L WQB-7 Standard

For further information on metal attenuation and groundwater, see:

Maxim Technologies, 1998, DRAFT FINAL, ALTERNATIVES ANALYSIS FOR MINE WASTE RELOCATION REPOSITORIES, Streamside Tailings Operable Unit, Butte/Silverbow NPL Site, Butte, Montana.

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MEMORANDUM

TO: Joel Chavez, Neil Marsh

FROM: B.G. Brian Grant, Bill Bucher WMB

DATE: April 19, 1999

RE: Evaluation of MWRR-2 Design Alternatives, Streamside Tailings Operable Unit, Silverbow Creek / Butte Area NPL Site

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At the request of the Montana Department of Environmental Quality, Maxim has analyzed several alternative designs for Mine Waste Relocation Repository No. 2 (MWRR-2). The purpose of this analysis is determine if there are cost-effective improvements to the design of MWRR-2 that could reduce the potential release of arsenic contaminated leachate from the repository. The current design of the repository, which calls for an eighteen inch soil cover over compacted waste, has the potential to release a small amount of fluid from its base with elevated levels of arsenic. These arsenic concentrations will be reduced as the leachate passes through the underlying materials and mixes with the groundwater system. (*Alternatives Analysis for Mine Waste Relocation Repositories*, Maxim Technologies, May 1998). Although calculations for the current design show that the arsenic concentration in groundwater should not exceed WQB-7 standard, the estimated concentration (17 µg/L) is just slightly below the WQB-7 standard (18 µg/L) which indicates that exceedances could occur. Therefore, these further analyses of alternative designs have been undertaken to see if there are cost effective methods to reduce further the load or concentration of arsenic discharged from the repository.

Several alternatives to the existing design for MWRR-2 were evaluated. The alternatives were proposed by MDEQ personnel for the purpose of determining whether other designs may be more cost effective for the project. These alternatives were evaluated against the existing repository design which consists of 22-inches of cover soil (18-inches after consolidation) placed over lime amended tailings/waste. The designs evaluated included:

Alternative 1: Add 6 inches of additional cover soil
Alternative 2: Add a compacted clay layer to cover system
Alternative 3: Add a GCL to the cover system
Alternative 4: Place a layer of iron oxides beneath the repository

Preliminary designs of each of the alternatives were prepared. The HELP model (ver. 3.0) was run for each alternative to determine the average annual percolation rate (i.e., leachate generation rate). Leachate was assumed to contain an arsenic concentration of 0.210 mg/L, based on attenuation testing which was previously performed (Maxim 1998). The percolation rate of leachate and the arsenic concentration in the leachate was then used for estimating arsenic concentrations in groundwater downgradient of the repository using assumed aquifer characteristics (Maxim, 1998). Calculations were performed using methods presented in the Maxim 1998 report. Cost estimates for each of the alternatives were derived based on unit costs presented in the Preliminary Remediation Cost Estimate (March 24, 1999) and the Maxim 1998 report.

Attached are descriptions for each of the alternatives and calculations used for completing the evaluation. Table 1 summarizes results of the analyses performed. Specific comments regarding each of the alternatives are provided below.

TABLE 1
SUMMARY OF ALTERNATIVES

	Existing Design	Alt 1	Alt 2	Alt 3	Alt 4
Description	ET cap with 18 inches soil	Thicker soil cap	Compacted clay liner	GCL	Iron layer
Average Percolation Rate (in./yr.)	0.61	0.28	0.26	0.03	0.61
As Loading (lbs/yr)	0.23	0.11	0.10	0.012	0.00
As Conc. In Groundwater (mg/L)*	0.017	0.013	0.013	0.011	0.011
Change in Cost Compared to Existing Design	--	+31,190	+901,400	+589,000	> 3,200,000
TOTAL ESTIMATED COST	$491,000	$522,000	$1,400,000	$1,100,000	>$3,690,000

* the values are calculated based on a background groundwater concentration for arsenic of 0.011 mg/L

Alternative 1- Thicker Soil Cap: An additional six-inch layer of cover soil was proposed as a way to further enhance evapotranspiration (ET) of moisture from the repository cover. With the additional cover, we assumed that effective depth of ET increased from 18-inches

for the existing design to 24-inches in the alternative design. This is an optimistic assumption that may over estimate the improvement in cap performance. The actual depth of effective ET is not known and is difficult to predict with great certainty. In the existing design, an ET depth of 18-inches was selected in part because of a relatively high level of certainty that this depth of ET can be achieved (the HELP model shows for Helena MT a default ET depth for bare soil of 14 inches and for soil with fair vegetation of 24 inches). While we selected an ET depth of 18-inches for the existing design, it is important to note that sufficient roots could develop to a depth of 24 inches, or greater, given that the material underlying the cover soil is amended tailings and should support root growth if sufficient water is present. It is uncertain whether the addition of 6-inches of cover soil (or greater thicknesses) will result in correspondingly greater ET depth. There may be other ways to further enhance the depth of ET besides adding cover soil (e.g., adding more organic amendment). Rich Prodgers indicated that if the alfalfa establishes well, very little or no water should percolate through the repository (personal communication, April 15, 1999).

Alternative 2 - Compacted Clay: The compacted clay liner (CCL) cover system design included a CCL thickness of 18 inches and six feet of cover material over the clay layer to protect it from freezing and cracking. An 18-inch sand drainage layer was placed over the clay.

Alternative 3 - Geosynthetic Clay Layer: This alternative was similar to Alternative 2 but included a GCL instead of a compacted clay layer. The alternative was more cost effective than Alternative 2 due primarily to a lower construction cost. The GCL cover system should also be more constructable than the CCL cover system. The GCL is covered by five feet of material, including a 18-inch thick sand drainage layer. We assumed this cover system extended over the entire repository. If additional design is completed for this alternative, we can look at lowering costs such as by reducing cover thickness over the upper portions of the repository and over areas where the 4:1 slope length is minimal.

Alternative 4 - Iron Layer Base: Providing an iron layer base was evaluated as a way to treat the leachate to acheive arsenic levels lower than WQB-7 standards prior to reaching the underlying groundwater. Testing by MSU Reclamation shows that the iron oxide material's effectiveness is reduced at lower concentrations of arsenic. They estimated a 28-inch layer of iron oxide material would be needed to attenuate arsenic levels below the WQB-7 standard. However, this estimate was based on a theoretical isotherm and is based on results for only one pore volume of leachate. Additional testing would be needed to confirm the effectiveness of this alternative prior to implementation.

SUMMARY

Results of the evaluation indicate that Alternative 3 is the most cost-effective for reducing the potential for arsenic concentrations in groundwater to exceed the WQB-7 arsenic standard. Alternative 3 insures a relatively low percolation rate through the repository and is not overly dependant on ET effectiveness. It provides greater groundwater protection the other alternatives, except Alternative 4. There are other low permeable synthetic materials besides GCL which could also be suitable for the project. The existing design (ET cover) costs substantially less than Alternative 3, but it will not be as effective in protecting groundwater. The GCL alternative was previously evaluated in the Maxim 1998 report and ranked high.

With regards to other alternatives evaluated, Alternative 1 does not appear to provide significantly greater protection to groundwater than the existing design, given that roots should penetrate into the amended tailings/waste if sufficient water is present. Alternative 2, the compacted clay liner, is similar to Alternative 3 but construction costs are approximately 30% greater, constructibility issues would be greater than for Alternative 3 and the design does not appear to be as protective as Alternative 3. Alternative 4, iron oxide layer, is significantly greater in cost than the other alternatives and the technology has not yet been proved effective.

DISCUSSIONS

Several discussions regarding issues pertinent to the MWRR-2 design are provided below.

Other Means to Minimize Impacts to Groundwater: Several other means to reduce potential impacts to groundwater could be evaluated. They include:

- Enhancing ET depth, possibly by using additional organic amendment and by providing more intensive followup maintenance
- Ensuring that tailings/waste material brought to the repository is not draining water.
- Requiring drying of the tailings/waste material to a specific moisture content, well below field capacity, prior to placement.
- Evaluating the lime amendment rates and resulting soil pHs to determine if there

is an optimum lime rate which minimizes mobility of arsenic while still maintaing an adequate soil pH.

o Evaluating the importance of tailings/lime mixing efficiency to arsenic mobility.

Repository Redesign: It is possible that the current repository design could result in a measurable increase of arsenic in groundwater downgradient of the repository. The initial preferred repository design, which extended the repository toe further to the south, resulted in the repository likely being positioned over a thicker aquifer section which transmits groundwater beneath the Silver Bow Creek drainage. For the existing design, the repository is located in an upland setting, aquifer thickness may be much less than the 10 feet used for the groundwater concentration estimates, and the groundwater could be mostly derived from the upland area beneath the repository. As a result, groundwater at the toe of the repository could be more susceptible to impact. Placing the tailings in a relatively dry state, coupled with a design similar to Alternative 3 would substantially alleviate potential impacts to groundwater.

MAXIM TECHNOLOGIES INC

BY Cameron Beal DATE 4/9/99

JOB TITLE SSTOA-Peach A Design JOB NUMBER

SUBJECT Re-evaluate MWRR-2 Effectiveness SHEET 1/7

Alternative #1 - Additional cover soil (from Alternatives report)

Add 6" To Design #2 which has 16" for a total of 24"

Use HELP Model - Start with Design #2 model used in Alternatives report

Model 2a - 24" Soil cover

Model 2a1 - 24" Soil cover + increase ET depth >24"

Annual Averages

Parameter	Design 2*	Design 2a	Design 2a1
Precip.	12.85"	12.83"	12.85"
Runoff	0.31"	0.31"	0.23"
ET	11.83"	11.83"	12.28"
Perc.	0.61"	0.61"	0.28"
Δ	0.1"	0.1"	0.1"

Design 2 is from "Alternatives report - current plan

Incremental Cost increase over existing design:

6" additional soil from BA-10 @ $5.00/cy

Assume 336,802 ft²

Volume = $336{,}802\ ft^2 \times 0.5\ ft \times \frac{cy}{27\ ft^3} = 6{,}237\ cy$

Cost = 6,237 cy × $5.00/cy = $31,190

MAXIM TECHNOLOGIES INC

BY Cameron Beul DATE 4/13/99

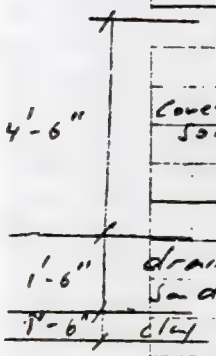
JOB TITLE SSTOU - Reach A Design JOB NUMBER

SUBJECT Re-evaluate MWRR-2 Effectiveness SHEET 2/7

Alternative #2 - Clay liner in cap

Use design #3 from Alternatives report with the following changes

- Add 30" coversoil to layer #1 for a total of 54" cover soil, resulting in a total cover of 72" (including 18" of drainage layer)
- Replace GCL with an 18" compacted clay liner



HELP model results compared with current design

Parameter	Current	CCL
Precip	12.85"	12.85"
Runoff	0.31"	0.233"
ET	11.83"	12.28"
Drainage		0.02"
Perc thru GCL		0.32"
Perc thru bottom	0.61"	0.26"
Δ	0.15"	0.06"

Incremental Cost Increase over existing design

	# units	unit	unit cost	cost
(54"-18") => 36" Coversoil	37,422	cy	$5.00	$187,110
18" Drainage Mat.	18,711	cy	$15.00	$280,665
Filter Fabric	336,802	sf	$0.10	$33,680
HDPE Toe Drain Pipe	1,000	lf	$14.25	$14,250
Excavate + Backfill	200	cy	$5.00	$1,000
~~Filter Fabric~~	~~336,802~~	~~sf~~	~~$0.10~~	~~$33,680~~
Clay, delivered	18,711	cy	$20.00	$374,220
Clay compaction	18,711	cy	$0.56	$10,478
				$901,403

MAXIM TECHNOLOGIES INC

BY Cameron Beul DATE 4/13/99

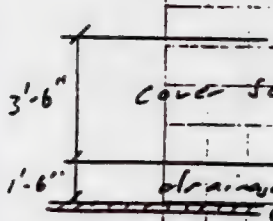
JOB TITLE SSTOU - Reach A Design JOB NUMBER

SUBJECT Re-evaluate MWRR-2 Effectiveness SHEET 3/7

Alternative #3 - GCL in cap.

Same as design #3 in alternatives report

Effectiveness per HELP model compared with current design



Parameter	Current	GCL
Precip.	12.85"	12.85"
Runoff	0.31"	0.23"
ET	11.83"	12.28"
Drainage		0.31"
Perc thru GCL		0.03"
Perc thru bottom	0.61"	0.01"
Δ storage	0.10"	0.02"

Cost increase over existing design:

	# units	unit	unit cost	cost
24" coversoil	24,950	cy	$5.00	$124,750
18" drainage sand/gravel	18,711	cy	$15.00	$280,665
Filter fabric	336,902	sf	$0.10	$ 33,680
HDPE Toe Drain Pipe	1,000	lf	$14.25	$ 14,250
Excavate + Backfill	200	cy	$5.00	$ 1,000
GCL installed	336,802	sf	$0.40	$134,721
				$589,066

MAXIM TECHNOLOGIES INC

BY Cameron Beal DATE 4/12/99

JOB TITLE SSTOU - Reach A Design JOB NUMBER

SUBJECT Re-evaluate MWRR-2 Effectiveness SHEET 4/7

Alternative #4 - Iron Layer Base

Called John Goering, RRU, MSU

- their source for the Red Iron Oxide they used for their analysis was Dyce Chemicals - Billings, MT - 248-3131 - Red Iron Oxide #37

Called Dyce Chemicals - 248-3131

talked with Mark Redfern. Asked for a price for a large volume delivery to Butte. He quoted me $250-$300/Ton

Volume required - 28" (based on MSU report) thick x Area of mine waste "footprint"

Footprint = 326,798 ft² (digitized area)

$$Vol = 326{,}798\,ft^2 \times \frac{28\,in}{12\,\frac{in}{ft}} \times \frac{cy}{27\,ft^3} = 28{,}242\,cy$$

Estimate weight of Iron material

Assume weight of material if it were sand = $110\,lb/ft^3$

for Sand = $2.65\,g/cm^3$, Hematite = $4\,g/cm^3$, Wim = $110\,lb/ft^3 \times \frac{4\,g/cm^3}{2.65\,g/cm^3} = 166\,lb/ft^3$

$$Cost: 28{,}242\,cy \times 27\,\frac{cf}{cy} \times \frac{166\,lb}{cf} \times \frac{1\,ton}{2{,}000\,lb} \times \frac{\$250}{ton} = \boxed{\$14{,}100{,}000}$$

Try to identify cheaper source Spano 444-4755

Iron mine north of White Sulfur - Spanish Creek

Irving Sewell - Hallett Mineral 222-1446

$24/Ton 2' minus FOB

~$16/Ton delivery To Butte

$40/Ton 2' minus iron ore delivered To Butte

MAXIM TECHNOLOGIES INC

BY Cameron Beul DATE 4/9/99

JOB TITLE SSTOU- Reach A Design JOB NUMBER

SUBJECT Re-evaluate MWRR-2 Effectiveness SHEET 5/7

Alternative #4 - Iron layer base (cont.)

Hallet Mineral - Montana

$40/ton at 8" minus iron ore delivered To Butte

$10/ton - assumed cost of milling ore To fine grade

$50/ton

Assuming this material would have the same effectiveness as the Dyce Chemical product Tested by MSU, then:

$$28{,}242\,CY \times \frac{2750\,lb}{CY} \times \frac{1\,ton}{2000\,lb} \times \frac{\$50}{ton} = \$3{,}242{,}000$$

These costs do not assume any special mixing which may be required

MAXIM TECHNOLOGIES INC

BY Brian Grant DATE 4/15/99

JOB TITLE SSTOU - Reach A Design JOB NUMBER

SUBJECT SHEET 6/7

COMPARE ALTERNATIVES

A = 8 Acres

	Existing Design	ALT 1	ALT 2	ALT 3	ALT 4
Description	ET	Thicker Soil Cap	Compacted Clay	GCL	iron layer
Average Percolation Rate (in/yr)	0.61	0.28	0.26	0.03	0.61
Arsenic loading (lb/yr) ① assume [As] = 210 µg/L	0.28	0.11	0.10	0.012	0.00 ②
Arsenic Conc. in Groundwater ③ (mg/L)	0.017	0.013	0.013	0.011	0.011 ②
	note: these values calculated based on an assumed background concentration of As in groundwater of 0.011 mg/L				
Change in Cost Compared to Existing Design	—	+31,190	+901,400	+589,000	+14,000,000
TOTAL ESTIMATED COST	$491,000	$522,000	$1,400,000	$1,100,000	$14,490,000

① Calculated based on "Alternatives Analysis for Mine Waste Repositories" Maxim 1998. As concentration in leachate = 210 µg/L, Area = 10 Acres, Loading rate = 0.29 lb/year for a percolation rate = 0.61 in/year. For ALT 1, the loading rate was calculated as follows:

$$\text{Loading} = 0.29\ \text{lb/year} \times \frac{8\ \text{Acres}}{10\ \text{Acres}} \times \frac{0.28\ \text{in/yr}}{0.61\ \text{in/yr}} = 0.11\ \text{lb/yr}$$

② Assumed no As in leachate for comparison with other alternatives. Additional testing necessary to better evaluate iron layer potential in removing all As from leachate.

③ Calculated based on As concentration in groundwater for Existing design calculated in Design Report of 0.011 mg/L As in background GW and 0.210 mg/L in Leachate

MAXIM TECHNOLOGIES INC

BY _____ DATE _____

JOB TITLE _____ JOB NUMBER _____

SUBJECT _____ SHEET 7/7

(3) Cont. For ALT 1, the As GW concentration was calculated as follows.

From Design Report, For Existing Design (ET cap)

$$[C]_{As} = \frac{Q_{GW} \times C_{GW} + Q_{Leach} \times C_{Leach}}{Q_{GW} + Q_{Leach}}$$

$$= \frac{(2.83\ ft^3/day \times 0.011) + (0.035\ ft^3/day \times 0.210\ mg/L)}{2.83\ ft^3/day + 0.035\ ft^3/day}$$

$$= 0.017\ mg/L$$

Q_{GW} = Groundwater flow rate
C_{GW} = Background concentration of Arsenic
Q_{Leach} = Leachate flow rate
C_{Leach} = Arsenic concentration in leachate

For ALT 1, use the following value for Q_{Leach}

$$Q_{Leach,Alt.} = Q_{Leach,existing} \times \frac{Perc_{Alt.}}{Perc_{existing}}$$

$$= 0.035\ ft^3/day \times \frac{0.28}{0.61}$$

$$= 0.039\ ft^3/day$$

Recalculate $[C]_{As}$ in GW for ALT 1

$$[C]_{As} = \frac{(2.83 \times 0.011) + (0.039 \times 0.210)}{2.83 + 0.039}$$

$$= 0.013$$

ALT 2, $Q_{Leach} = 0.03$
ALT 3, $Q_{Leach} = 0.004$
ALT 4, $Q_{Leach} = 0.085$

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MEMORANDUM

To: Joel Chavez, Neil Marsh

From: Bill Bucher WHB

Date: June 8, 1999

Subject: Role of Attenuation in Arsenic Migration from Mine Waste Relocation Repository, Reach A of the Streamside Tailings Operable Unit - Butte-Silver Bow NPL Site.

This memorandum clarifies our understanding of the role attenuation plays in the migration of arsenic from the base of Mine Waste Relocation Repositories to be constructed as part of the remedial action for the Streamside Tailings Operable Unit. Potential migration of arsenic from the repositories is a concern because arsenic, unlike the heavy metals, is not necessarily immobilized by treatment of the waste with lime. If arsenic migrates from the base of a repository, it is possible that underlying groundwater quality could be affected. This memorandum summarizes our knowledge of what effect the attenuation capacity of underlying material is expected to have on arsenic migration. The source of our information is attenuation studies performed by Maxim in 1997 which were presented in the report *Alternatives Analysis for Mine Waste Relocation Repositories* (Maxim, 1998).

Our analysis of the effects of arsenic on groundwater relied on the following information:

- Values for leachate concentrations obtained from synthetic leaching solution derived from tailings taken from the Silver Bow Creek floodplain,
- Laboratory values for arsenic concentrations after attenuation by site materials,
- Aquifer characteristics based on materials samples from the site and general site knowledge, and
- The concentration of arsenic in groundwater in well CG-15 near Whisky Gulch.

Using the above information, we calculated the expected concentrations of arsenic in groundwater for different alternative repository designs. In particular, we calculated a range of concentrations for arsenic in groundwater for the design proposed for Reach A remedial action, namely, an 18 inch soil cap over treated waste. The calculated concentration depends on the attenuation capabilities of the underlying materials. Based on our evaluation of the soil attenuating capabilities of material taken from the proposed repository site, the expected future concentration of arsenic in groundwater below the site is 12 micrograms per liter (μg/l). This is just slightly higher than the background groundwater concentration of 11.4 μg/l taken from well CG-15.

At some point in the future, it is possible that the soil attenuation capacity will be exhausted. At that time, leachate from the repository will no longer be attenuated by the underlying soil, and groundwater arsenic concentrations are expected to rise. If no subsurface attenuation of arsenic occurs, we predict that groundwater concentrations could rise to 17 μg/l, just below the state groundwater quality standard of 18 μg/l. It is not known at what point in the future this rise in concentration could occur. To determine when this rise might occur, long-term attenuation tests would need to be conducted that would measure the total attenuation capacity of the soils underlying the repository sites. Such studies have not been conducted.

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 4

THICKNESS	=	240.00	INCHES
POROSITY	=	0.4370	VOL/VOL
FIELD CAPACITY	=	0.1050	VOL/VOL
WILTING POINT	=	0.0470	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1050	VOL/VOL
EFFECTIVE SAT. HYD. COND.	=	0.170000002000E-02	CM/SEC

GENERAL DESIGN AND EVAPORATIVE ZONE DATA

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 6 WITH A FAIR STAND OF GRASS, A SURFACE SLOPE OF 5.% AND A SLOPE LENGTH OF 200. FEET.

SCS RUNOFF CURVE NUMBER	=	70.70	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	9.000	ACRES
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	5.310	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	16.020	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	2.376	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	28.620	INCHES
TOTAL INITIAL WATER	=	28.620	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

EVAPOTRANSPIRATION AND WEATHER DATA

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
Butte MONTANA

STATION LATITUDE	=	46.00	DEGREES
MAXIMUM LEAF AREA INDEX	=	2.50	
START OF GROWING SEASON (JULIAN DATE)	=	135	
END OF GROWING SEASON (JULIAN DATE)	=	273	
EVAPORATIVE ZONE DEPTH	=	36.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	7.80	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	63.00	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	54.00	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	49.00	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	63.00	%

NOTE: PRECIPITATION DATA FOR Butte MT

WAS ENTERED FROM A NOAA DATA FILE.

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA

```
**********************************************************************************
**********************************************************************************
**                                                                              **
**                                                                              **
**                HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE                 **
**                     HELP MODEL VERSION 3.05a  (5 JUNE 1996)                  **
**                     DEVELOPED BY ENVIRONMENTAL LABORATORY                    **
**                       USAE WATERWAYS EXPERIMENT STATION                      **
**                FOR USEPA RISK REDUCTION ENGINEERING LABORATORY               **
**                                                                              **
**                                                                              **
**********************************************************************************
**********************************************************************************

PRECIPITATION DATA FILE:     n:\sst\design\reposit\helpmod\PRECIP3.D4
TEMPERATURE DATA FILE:       N:\sst\design\reposit\helpmod\TEMP3.D7
SOLAR RADIATION DATA FILE:   n:\sst\design\reposit\helpmod\SOLAR3.D13
EVAPOTRANSPIRATION DATA:     n:\sst\design\reposit\helpmod\MWRR2.D11
SOIL AND DESIGN DATA FILE:   n:\sst\design\reposit\helpmod\MWRR2.D10
OUTPUT DATA FILE:            n:\sst\design\reposit\helpmod\mwrr2.OUT


TIME:  14:10      DATE:   3/ 3/1998


**********************************************************************************

     TITLE:  SSTOU- MWRRs: Design 2

**********************************************************************************


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
              WERE SPECIFIED BY THE USER.


                                LAYER  1
                                --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER
                      MATERIAL TEXTURE NUMBER   6
        THICKNESS                      =     18.00   INCHES
        POROSITY                       =      0.4530 VOL/VOL
        FIELD CAPACITY                 =      0.1900 VOL/VOL
        WILTING POINT                  =      0.0850 VOL/VOL
        INITIAL SOIL WATER CONTENT     =      0.1900 VOL/VOL
        EFFECTIVE SAT. HYD. COND.      =  0.720000011000E-03 CM/SEC
      NOTE:  SATURATED HYDRAULIC CONDUCTIVITY IS MULTIPLIED BY  3.63
               FOR ROOT CHANNELS IN TOP HALF OF EVAPORATIVE ZONE.


                                LAYER  2
                                --------
```

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
16.80	22.00	28.30	38.20	47.20	56.20
62.90	61.20	50.60	41.00	27.70	17.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR HELENA MONTANA
AND STATION LATITUDE = 46.00 DEGREES

WARNING: TEMPERATURE FOR YEAR 1898 USED WITH PRECIPITATION FOR YEAR 1998

WARNING: SOLAR RADIATION FOR YEAR 1898 USED WITH PRECIPITATION FOR YEAR 1998

****

AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1896 THROUGH 1995

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.62	0.54	0.83	1.03	1.93	2.29
	1.27	1.13	1.15	0.81	0.64	0.61
STD. DEVIATIONS	0.49	0.42	0.49	0.61	1.11	1.42
	0.94	0.78	0.84	0.62	0.56	0.43
RUNOFF						
TOTALS	0.003	0.023	0.065	0.071	0.020	0.004
	0.000	0.000	0.000	0.000	0.008	0.001
STD. DEVIATIONS	0.019	0.071	0.207	0.162	0.116	0.035
	0.000	0.000	0.000	0.000	0.048	0.005
EVAPOTRANSPIRATION						
TOTALS	0.447	0.390	0.478	0.706	1.950	2.447
	2.116	1.090	1.132	0.416	0.274	0.367
STD. DEVIATIONS	0.174	0.169	0.184	0.309	0.532	0.817
	1.259	0.740	0.701	0.213	0.131	0.171
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0635	0.0627	0.0725	0.0720	0.0804	0.0816
	0.0755	0.0521	0.0383	0.0399	0.0458	0.0573
STD. DEVIATIONS	0.0548	0.0488	0.0516	0.0473	0.0498	0.0425
	0.0377	0.0266	0.0337	0.0451	0.0484	0.0537

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1896 THROUGH 1995

	INCHES		CU. FEET	PERCENT
PRECIPITATION	12.85	(3.100)	419923.9	100.00
RUNOFF	0.195	(0.3838)	6375.86	1.518
EVAPOTRANSPIRATION	11.814	(2.4757)	385959.22	91.912
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.74156	(0.46987)	24226.664	5.76930
CHANGE IN WATER STORAGE	0.103	(1.1512)	3362.06	0.801

****

****

PEAK DAILY VALUES FOR YEARS 1896 THROUGH 1995

	(INCHES)	(CU. FT.)
PRECIPITATION	3.00	98010.000
RUNOFF	1.060	34640.3086
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.011693	382.01294
SNOW WATER	4.65	151997.8280

MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2594
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0660

****

****

FINAL WATER STORAGE AT END OF YEAR 1995

LAYER	(INCHES)	(VOL/VOL)
1	2.3375	0.1299
2	36.1171	0.1505
SNOW WATER	0.456	

****
****

APPENDIX F-6

Old Highway 10 Correspondence

Butte-Silver Bow Planning Board

January 12, 1998

RECEIVED
JAN 14 1998
MAXIM TECHNOLOGIES
HELENA, MT

Mr. Bill Bucher
Project Engineer
Maxim Technologies, Inc.
1610 B Street
P.O. Box 4699
Helena, MT 59604

Re: Butte-Silver Bow comments on Mine Waste Relocation Repositories
MWRR-2, MWRR-2A, Streamside Tailings, Subarea 1

Dear Mr. Bucher,

The following is a response to your request for Butte-Silver Bow comments concerning the construction of repository MWRR-2A, in particular using a portion of old US Highway 10 for siting the repository. Butte-Silver Bow would have no concerns of siting the repository over a portion of US Highway 10. However, please be advised that the Montana Department of Transportation (MDT) must approve this action given that US Highway 10 is officially designated a state roadway. Butte-Silver Bow would also appreciate formal acknowledgement from the MDT indicating their final decision to permanently close US Highway 10 and their approval of this location for use as a repository.

If the decision is made to use a portion of US Highway 10 as a repository, Butte-Silver Bow would like to ensure that sufficient distance is maintained between the south toe of the repository and the railroad tracks so that the proposed trail system could be constructed. If any further information is required from Butte-Silver Bow, please do not hesitate to ask.

Sincerely,

Shane Worley

Shane Worley
Superfund Technical Specialist

cc: Jon Sesso, BSB Planning Dept
Jim Johnston, BSB Public Works Dept
Dan Dennehy, BSB Health Dept
Andy Young, Montana DEQ
Jason Giard, Butte District Engineer

RECEIVED
FEB 16 1998
MAXIM TECHNOLOGIES
HELENA, MT

Montana Department of Transportation
Helena, Montana 59620

Memorandum

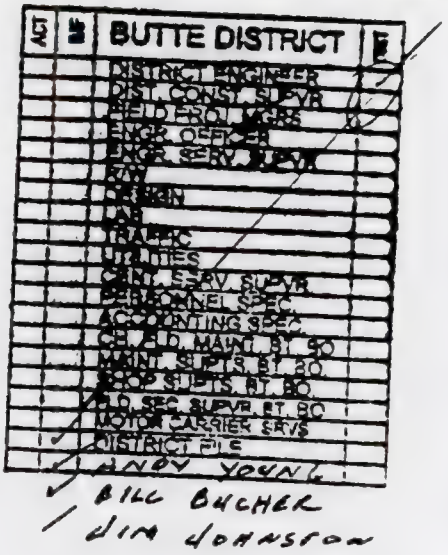
RECEIVED
FEB 12 1998
DEPT. OF TRANSPORTATION
Butte, Montana 59701

To: Jason Giard, P.E.
District Administrator-Butte

From: Barbara A. Smith BAS
Property Manager

Date: February 10, 1998

Subject: FAP 70-A
Silverbow County



This memo is in response to your inquiry to Greg asking if we have maps showing MDT ownership of old Highway 10.

The area Maxim Technologies is inquiring about is in Section 22, Township 3 North, Ranch 3 North, lying between Rocker and Butte. I have been through all the micro-film that we have for that area and made copies of some of the correspondence relating to this area. I couldn't find the original maps for that section but the "as builts" could be in the basement. There are no acquisition documents for Highway 10 in that section.

I did find a copy of a letter to the Board of County Commissioners, Silver Bow County, dated January 23, 1958 stating that the Highway Commission, in its regular session on January 16, approved the abandonment of the old highway. A copy of that letter is attached.

My research definitely shows that the old Highway 10 was abandoned to the County. If you want me to look further or obtain any additional documents, please let me know.

January 23, 1958

Board of County Commissioners
Silver Bow County
Butte, Montana

Gentlemen:

In view of the fact that the new location of U. S. Highway 10 between Butte and Rocker has been completed, the Highway Commission in regular session on January 16 approved the abandonment of the old highway better described as follows:

> Starting at the intersection of the old U. S. Highway 10 intersection with the west line of Section 16, Township 3 North, Range 8 West; thence southeasterly along the old highway, through the Town of Rocker; thence in an easterly direction along the old highway route to a point on Excelsior Street in Butte, which point is 150' south of the crossing of the old U. S. Highway No. 10 with the north line of the Bonanza Lode Mining Claim, Survey No. 467, a distance of approximately 3.85 miles.

The project concerned is at Station 114 + 38.3 on PAP-70-A, [illegible] Agreement 3 through WPOE-70-A, PAP-70-A, [illegible] Agreement 3, [illegible] PAP-70-A.

We are attaching a print of the right of way showing the approximate location of the highway being abandoned.

This is to officially notify you that the maintenance and the full responsibility for the above described portion of the replaced U. S. Highway 10 now rests entirely with Silver Bow County.

Official action accomplishing this transfer is a part of the minutes of formal action taken by the State Highway Commission in regular session January 16, 1958.

Yours very truly,

John B. Wheeler
Secretary

JBW/k

cc: U. S. Bureau
[illegible]
U. S. Bureau

NRH 10
Rocker

January 23, 1958

Board of County Commissioners
Silver Bow County
Butte, Montana

Gentlemen:

In view of the fact that the new location of U. S. Highway 10 between Butte and Rocker has been completed, the Highway Commission in regular session on January 16 approved the abandonment of the old highway better described as follows:

> Starting at the intersection of the old U. S. Highway 10 intersection with the west line of Section 16, Township 3 North, Range 8 West; thence southeasterly along the old highway, through the Town of Rocker; thence in an easterly direction along the old highway route to a point on Excelsior Street in Butte, which point is 150' south of the crossing of the old U. S. Highway No. 10 with the north line of the Bonanza Lode Mining Claim, Survey No. 485, a distance of approximately 3.25 miles.

The project concerned is at Station 314 + 38.3 on FAP-70-A, NRH-70-A Agreement 3 through NPGH-70-A, FAP-70-A, NRH-70-A Agreement 3, NRH-70-A through NPH-70-6.

We are attaching a print of the right of way showing the approximate location of the highway being abandoned.

This is to officially notify you that the maintenance and the full responsibility for the above described portion of the replaced U. S. Highway 10 now rests entirely with Silver Bow County.

Official action accomplishing this transfer is a part of the minutes of formal action taken by the State Highway Commission in regular session January 16, 1958.

Yours very truly,

John D. Wheeler
Secretary

JDW/d

cc: W. E. Bowdon
L. Chittim
E. O. Parsons

November 14, 1979

FAP 70-A
Request for Plans
Ref: 68-GLC

Mr. Jack L. McLeod & Associates, Inc.
P. O. Box 3748
Butte, MT 59701

Dear Mr. McLeod:

Enclosed are three sheets of highway plans for project FAP 70-A, covering the section of old Highway 10 over Section 22, Township 3 North, Range 8 West. We have no right-of-way plans or other details concerning the particular width of the right-of-way for this highway, but these plans do show the approximate alignment of the old highway.

The effect of the Commission minutes of Janurary 16, 1958, relinquished jurisdiction of this highway to Silver Bow County. Thus the county could continue to maintain this road or could take further action for its abandonment.

We are also enclosing an invoice in the amount of $6.00 to help defray the cost of printing and mailing the plans. Please make your remittance payable to the Montana Department of Highways.

If we can be of further assistance, please let us know.

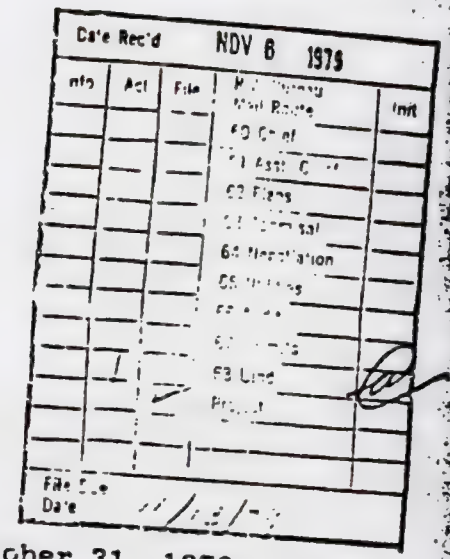
Sincerely,

Robert E. Champion, P.E.
Chief-R/W Bureau

Enclosures

REC/WS/dd/3B

Jack L. McLeod & Associate
DEVELOPERS
MEMBER FIRM
NATIONAL INSTITUTE OF FARM AN
REALTORS NATIONAL MARKETING



November 5, 1979

Mr. Robert E. Champion, P.E.
Chief, Right of Way Bureau
State of Montana
Department of Highways
Helena, Montana 59601

RE: AP 70-A
Request for Plans
68-GC

Dear Mr. Champion:

I appreciated your response of October 31, 1979, to my previous request concerning the matter of the closing of Old Highway 10 between Butte and Rocker. I am interested in the area of closure of this highway in view of the fact that I am the owner of the Sonora #2296, Arlington #3481 and Josephine #3480 in Section 22, Township 3 North, Range 8 West. The old Highway traversed these properties.

It would appear that my ownership is approximately 3,000 lineal feet over which and across old Highway 10 traversed. I would be more than willing to pay you $2.00 per sheet for any plans or right-of- way notes you have concerning this property.

Also if you wish to comment you might notify me as to the exact intent of the commission minutes of January 16, 1958, abandoning this highway. Does this mean, for instance, that the property would revert to the owners on either side of the right-of-way? Or is there some other means for this abandonment. I certainly welcome any response you might make and assistance you might render.

Thank you.

Very truly yours,

Jack L. McLeod
JLM/pf

REALTOR®
P. O. BOX 3748 • BUTTE, MONTANA 59701 • PHONE (406) 494-3122

DEPARTMENT OF HIGHWAYS

October 31, 1979

FAP 70-A
Request for Plans
Ref: 68-GC

Jack L. McLoed & Associates, Inc.
P.O. Box 3748
Butte, Montana 59701

Dear Mr. McLoed:

This will acknowledge your letter of October 11, 1979, requesting information concerning the abandonment of a portion of old Highway 10 between Butte and Rocker.

A copy of the Highway Commission Minutes of January 16, 1958 abandoning this highway is enclosed. Also enclosed is a county map on which we have indicated in red the approximate route of the abandoned highway.

Our information concerning the exact location of this old highway is quite limited. This highway was reconstructed in about 1934 with some new realignment at that time. A considerable amount of the old right of way was also utilized with the 1934 construction. We do not have plans showing the particular location and width of the then existing right of way.

It is possible we may have some plans in the area in which you are interested. If you would provide us with a more specific area for which you would like plans we can review what we have and possibly provide copies for your area of interest. Our charge for processing, printing and mailing these plans would be $2.00 per sheet.

Sincerely,

Robert E. Champion, P.E.
Chief, Right of Way Bureau

REC:WS:cv
Enclosure
cc: Mail and File

FAP 70
Project F

INTER-DEPARTMENTAL MEMORANDUM

DEPARTMENT OF HIGHWAYS

To Chief - Right of Way Bureau

From Supervisor - R/W Section (Butte)

Date October 15, 1979

Subject FAP 70-A

Attn: 62 - MLN

This office received a request from Mr. Tom Cash, Director of Public Works requesting information existing R/W on Project FAP 70-A.

Mr. Cash would like to know if the State had acquired R/W in Section 22, Township 3 N.,Range 8 W. from Sonora Mining Claim , Mineral Survey 2296 and 536 and the Arlington Mining Claim,Mineral Survey 3481.

The reason for this request is that a new sledge pipe line was constructed within the old R/W on Highway 10, and they have received a complaint from the owner of the above mentioned mining claims stating that there is no R/W for said Highway 10 from the two mining claims and that the party is requesting damages.

Mr. Cash was also informed sometime back by former Division Construction Engineer, R.B. Dundas, that the maintenance of Highway 10-A was turned over to Silver Bow County.

Would you please provide information as to when the maintenance of old Highway 10 was turned over by the Department.

Any information that you can provide concerning this will be greatly appreciated.

JFM:lc

Date Rec'd	OCT 17 1979			
Info	Act	File	Project Main Route	Init
			60 Chief	
			61 Asst. Chief	
	I		62 Planning	
			63 Right of Way	
			64 Design	
			65 Utilities	
			66 Airport	
			67 Permits	
			68 Land	
			Project	
File Due Date				

Avoid Verbal Instructions
Supervisor - R/W Section....Butte

MONTANA DEPT. OF HIGHWAYS

Jack L. McLeod & Associates

DEVELOPERS

OCT 15 1979

MEMBER FIRM
NATIONAL INSTITUTE OF FARM AND LAND REALTORS

Date Rec'd OCT 22 1979

Info	Act	File	R/W Bureau Mail Route	Init
			60 Chief	
			61 Asst. Chief	
			62 Plans	
			63 Appraisal	
			64 Negotiation	
			65 Utilities	
			66 Audit	
			67 Permits	
			68 Land	
			Project	

File Due Date

October 11, 1979

Mr. Ron Richards
Director
Montana Department of Highways
Helena, Montana 59601

Dear Mr. Richards:

On January 23, 1958, John D. Wheeler, Secretary of the Montana Highway Commission notified the Board of County Commissioners of Silver Bow County, Montana, of the abandonment of a portion of old highway 10 between Butte and Rocker. I am enclosing a copy of the communication I have concerning this matter.

I have a current interest in property abutting the old highway. I would be appreciative of your agency if I might receive a copy of the Commission Minutes of January 16, 1958, at which time the Highway Commission approved the abandonment of the old highway. I would also like to obtain a copy of the print showing the approximate location of the highway being abandoned which depicts the highway right-of-way.

Time is of essence - any assistance you might render would be appreciated.

Thank you.

Very truly yours,

Jack L. McLeod
JLM/pf
enc.

REALTOR®

P. O. BOX 3748 • BUTTE, MONTANA 59701 • PHONE: (406) 494-3122

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS

May 18, 1976

[redacted]

Mr. Leonard Haxby
Attorney at Law
P. O. Box 3725
Butte, Montana 59701

NRH 70-A
Waite Oil Compa
Bulk Plant near
Butte
Ref: 68-HLJ

Dear Leonard -

This will acknowledge receipt of your letters of May 3, 1976, regarding the old abandoned highway by the Waite Oil Company Bulk Plant near Butte.

This old highway was officially abandoned by the State Highway Commission in regular session on January 16, 1958. Enclosed is a copy of a letter explaining the abandonment and transferring full responsibility and maintenance to Silver Bow County.

The Department of Highways never acquired any property rights for right-of-way for the older concrete roadway that runs northeasterly across the Garfield Mining Claim. It is believed that this old roadway was constructed by the county and they of course would have made the necessary arrangements for the road right-of-way.

Because the Department of Highways does not own the right-of-way for this old roadway, they cannot control any encroachments, nor can they take any action to revert any property right to the contingent landowners.

Sincerely,

H. J. ANDERSON
DIRECTOR OF HIGHWAYS

By [signature]
Robert L. Champion, P. E.
Chief - Right of Way Bureau

REC:HLJ:pm
cc: Supvr. - Permits Section
Supvr. - Field R/W Section - Butte

LEONARD J. HAXBY

Attorney at Law

EXECUTIVE VI
323 EAST FRONT
P O BOX 3
BUTTE MONTANA
TELEPHONE (406)

May 3, 1976

State of Montana
Montana Highway Department
Centralized Services Division
Helena, Montana 59601

Gentlemen:

Enclosed please find two copies of areas, one near the Petrolane facility in Butte, just south of Interstate 15-90 Busine Loop and one copy of the old abandoned highway west and south of the Highway by the Waite Oil Company Bulk Plant near Butte.

In this regard, I represent the Waite Oil Company, who is the owner of the property on both sides of subject abandoned high with the exception of a small area owned by Petrolane of Butte an who are desirous of having subject property as it abutts their property abandoned, having the land revert to them as owner.

In this regard, county real estate records will reveal that Waite Oil Company is, in fact, the owner of the lands on both sides of said old roadway. If there is a formal petition to have these portions of old highways abandoned and revert to the contingent land owners, please advise.

Sincerely,

LEONARD J. HAXBY
Attorney at Law

LJH/nn
Encl.

Date Rec'd. MAY 0
Init
R/W BUREAU
MAIL ROUTE

INTER-DEPARTMENTAL MEMORANDUM

DEPARTMENT OF HIGHWAYS

To Robert E. Champion, Supvr. Right of Way Section

From R.B. Dundas, P.E. Supvr. Div. Constr. Section - Butte

Subject: N.R.H. 70
Ref: 68-H
Date November 28

Relative to your inquiry concerning the subject project and the Wa
wish to acquire the old roadway this office would make the following co

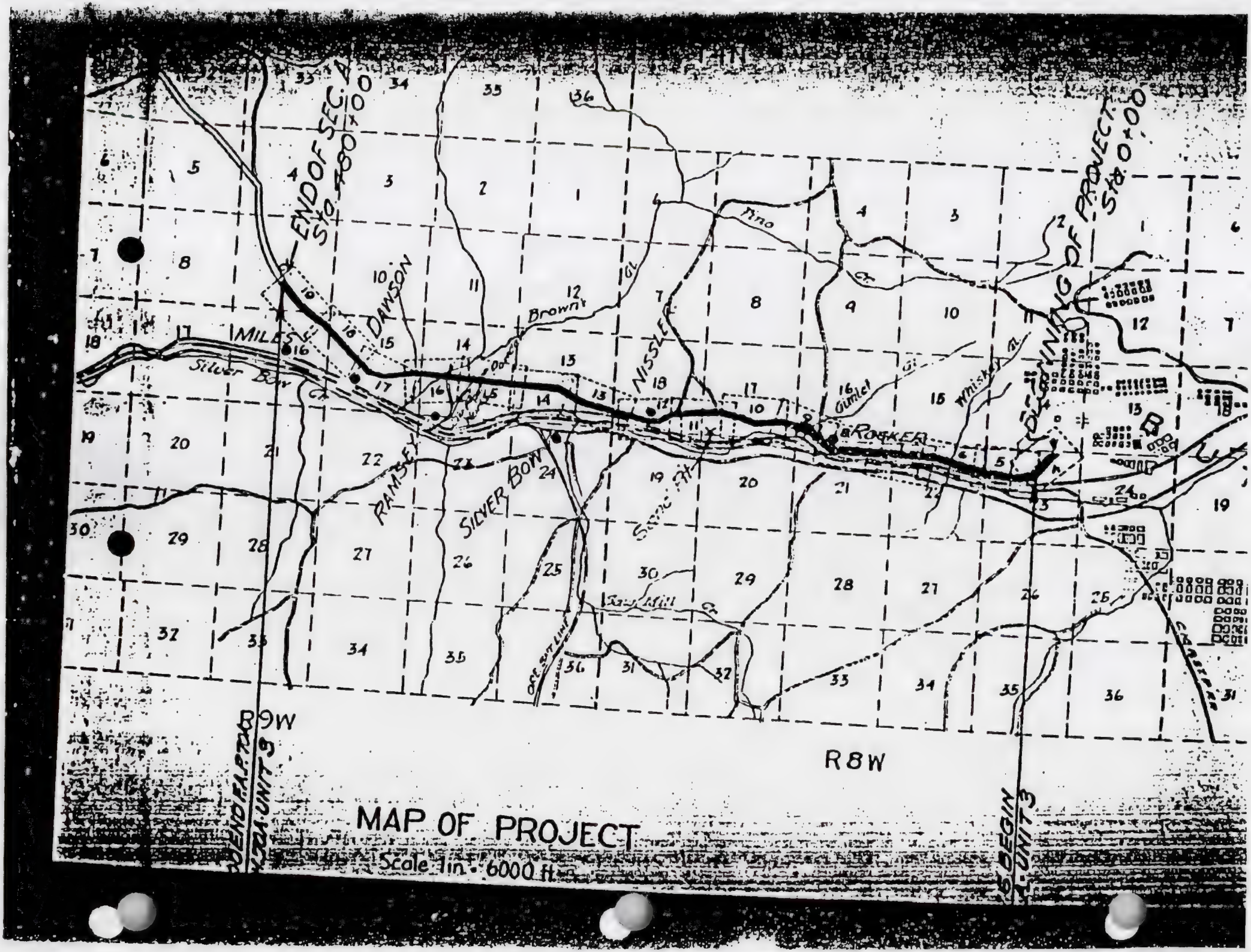
I would not recommend any release of any of this old roadway other
area colored in green located between F.A.P. 70A highway Sta. 4+60 and
highway Sta. 459+50 approximately.

It cannot be determined by this office from records whether or not
was acquired in this area as it is believed that this old concrete road
ted by County [redacted].

The other areas that this old road is located in must be retained

RBD/ajm

Avoid Verbal Instru


END OF SEC. A
Sta 480+00
BEGINNING OF PROJECT
Sta 0+00
DAWSON
NISSLER
RAMSEY
SILVER BOW
MILES
Silver Bow Cr.
Brown's Gl.
Pino Cr.
Gimlet Gl.
Whiskey Gl.
ROSKER
Stone Cr.
Mill Cr.
Cabbage Cr.
OFF SET LINE
R9W
R8W
MAP OF PROJECT
Scale 1in. = 6000 ft.

APPENDIX G

LIME RESOURCES

Preliminary Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

Lime Rate Calculation Method

The total lime quantity for Subarea 1, Reach A of the Streamside Tailing Operable Unit was calculated based on soil pit data collected by Titan. Acid-base account analyses were performed on a total of 44 tailing/impacted soil materials within the reach resulting in a unique lime rate for each pit. The laboratory lime rates were determined from composite samples collected across the entire tailing thickness, which varied between pits. To compile the spatially varied field data, computer software was used to estimate the total lime requirement for Reach 1A.

Eagle Point Civil Series Software, Version 14.0b, was used to calculate the lime rate from field and laboratory data. Eagle Point is an engineering software package that runs in concert with AutoCAD, utilizing the AutoCAD calculation 'engine' to perform specific tasks, including calculation of volume. Since each soil pit location was surveyed, an accurate location for each pit was known. Quattro Pro spreadsheet software was used to determine a lime rate on a pounds per square foot basis for each soil pit location. This rate was determined by multiplying the acid-base account lime requirement by the excavation depth (tailing depth + 0.5 feet), and converting to the appropriate units. The lime rate was then coupled with the survey coordinates for each pit and output as an ASCII file. This ASCII file was subsequently read into Eagle Point as an x,y spatial point where the z axis was expressed as pounds of lime per square foot instead of elevation. AutoCAD was then used to draw a bounding line for the lime rate data set. The selected bounding line drawn was an approximation of the extent of tailings line drawn by Titan during Remedial Design. Eagle Point was then asked to calculate the area under the 3-D surface defined by each of the lime rate data points. The output volume was then converted to the appropriate units.

This same method was used to calculate the volume of tailings within the Reach 1A by modifying the input file to reflect the tailings depth rather than lime rate.

The resulting graphical output in support of the volume estimates reveals a complex, spatially varied distribution of samples.

TABLE G-1
LIME QUALITY, Subarea 1, Reach A
SSTOU Remedial Design

Material	ID	moisture (g/g)	% retained on No. 8 sieve	% retained on No. 60 sieve	% passing No 60 sieve	wet sieve % greater No 60 sieve	wet sieve % passing No 60 sieve	adjusted* % passing No 60 sieve	CCE minus 60 mesh	ECCE**
Kiln dust	concentrator	0	6.6	24.4	69	95.6	4.40	70.4	108.89	76.6
Kiln dust	duplicate		2.8	24.4	72.8	94	6.00	74.4	109.14	
Econolime	1001	0.269	29.7	40.8	29.5	96	4.00	32.3	96.46	22.8
Econolime	1001-d		29.9	39.4	30.7	94.6	5.40	34.4	97.06	33.4
Econolime	1002									
Econolime	1003	0.28	25.4	37.7	46.9	84.8	15.20	56.5	101.25	41.2
Econolime	1004									
Econolime	1005	0.311	25.2	30.7	44.1	82.1	17.90	54.1	104.25	38.9
Econolime	1006	0.232	24.6	35.1	40.3	77	23.00	54	102	42.3
Econolime	1007	0.209	25.8	39.4	34.8	78.4	21.60	48.9	99.4	38.4
Kiln dust	ckld 2001	0	0.1	10.5	89.4	97.6	2.40	89.7	85.8	76.9
Kiln dust	ckld 2002	0	1	26.8	72.2	84.9	15.10	76.4	81.2	62

*adjusted amount is the dry sieve plus wet sieve fractions less than 60 mesh
**ECCE is the laboratory measured CCE of the minus 60 mesh material, adjusted to the field sample by factoring in moisture content and particle size distribution of the bulk material
mean ECCE Kiln dust= **71.9**
mean ECCE Econolime= **38.8**
Cumulative tons Kiln Dust delivered to Subarea 1, Jan-Aug, 1997= **6437**
Cumulative tons Econolime delivered to Subarea 1, Jan-Aug, 1997= **49720**
Effective tons pure calcium carbonate, from Kiln Dust = **4626**
Effective tons pure calcium carbonate, from Econolime = **19315**
Effective tons pure calcium carbonate, total = **23940**

TABLE G-2
LIME REQUIREMENTS, Subarea 1, Reach A
SSTOU Remedial Design

Test Pit Sample	Total (%)Sulfur	Hot Water Sulfur (%) Sulfate	HCl Extractable Sulfur (%) Sulfide	HNO3 Extractable Sulfur (%) Sulfide	Residual Sulfur (%)	NP	TS-AB	TS-ABP	Pyritic S-AB	Pyritic S-ABP	SMP Buffer Lime ($CaCO_3$) Requirements	Total Lime Rate ($CaCO_3$)
						tons/1000 tons						
1S-1008	0.07	<0.01	0.01 u	0.03	0.01 u	27.47	0	27.47	0.88	26.59	0.0	2
1S-1003	0.13	0.05	0.01	0.05	0.02	29.08	4.16	24.92	1.8	27.28	0.0	3
1N-1037	0.12	0.04	0.01 u	0.08	0.01 u	11.29	3.84	7.44	2.49	8.8	0.0	4
1S-1069	0.16	0.05	0.02	0.06	0.03	48.69	5.13	43.57	2.33	46.37	0.0	4
1S-1085	0.25	0.11	0.07	0.03	0.04	39	7.72	31.28	2.53	36.47	0.0	5
1S-1047	0.24	0.11	0.03	0.02	0.08	3.76	7.38	-3.61	1.32	2.45	0.0	5
1N-1071	1.83	1.77	0.01 u	0.04	0.02	<1.0	57.19	-57.19	1.13	-1.13	1.8	5
1S-1027	0.22	0.09	0.02	0.08	0.04	12.54	6.72	5.82	2.72	9.82	0.0	5
1S-1080	0.15	<0.01	0.08	0.07	0.04	40.45	4.56	35.88	3.96	36.49	0.0	7
1N-1013	0.26	0.08	0.02	0.12	0.04	71.79	8.25	63.54	4.44	67.36	0.0	7
1S-1063	0.04	<0.01	0.01 u	0.02	0.01 u	<1.0	1.19	-1.19	0.77	-0.77	4.6	7
1S-1001	0.48	0.32	0.01 u	0.15	0.01 u	6.2	14.9	-8.7	4.7	1.5	1.0	8
1N-1086	0.12	<0.01	0.07	0.04	0.02	47.43	3.78	43.65	2.76	44.67	3.2	8
1N-1049	0.34	0.12	0.05	0.13	0.04	4.34	10.56	-6.22	5.43	-1.09	0.3	9
1S-1078	0.23	0.12	0.03	0.03	0.06	10.06	7.16	2.9	1.48	8.58	5.3	11
1N-1018	0.38	0.06	0.05	0.18	0.08	11.3	11.8	-0.5	7	4.3	0.0	12
1S-1038	0.27	0.12	0.02	0.12	0.01 u	6.27	8.28	-2.01	4.16	2.11	5.3	12
1N-1009	0.3	0.06	0.03	0.19	0.01	<1.0	9.3	-9.3	6.9	-6.9	5.3	15
1S-1056	0.17	<0.01	0.08	0.02	0.08	9.92	5.25	4.67	2.52	7.4	7.5	15
1S-1021	0.6	0.21	0.07	0.24	0.08	9.41	18.69	-9.28	8.93	0.48	1.0	16
1S-1015	0.38	0.08	0.07	0.23	0.01 u	1.25	11.88	-10.62	8.65	-7.39	3.9	16
1S-1035	0.35	0.12	0.01 u	0.23	0.01 u	<1.0	10.84	-10.84	7.22	-7.22	5.3	16
1N-1065	0.71	0.28	0.1	0.23	0.11	3.76	22.16	-18.39	9.33	-5.57	1.0	17
1S-1043	1.89	1.6	0.01	0.25	0.04	<1.0	59.06	-59.06	7.92	-7.92	4.6	17

TABLE G-2
LIME REQUIREMENTS, Subarea 1, Reach A
SSTOU Remedial Design

Test Pit Sample	Total (%)Sulfur	Hot Water Sulfur (%) Sulfate	HCl Extractable Sulfur (%) Sulfide	HNO3 Extractable Sulfur (%) Sulfide	Residual Sulfur (%)	NP	TS-AB	TS-ABP	Pyritic S-AB	Pyritic S-ABP	SMP Buffer Lime ($CaCO_3$) Requirements	Total Lime Rate ($CaCO_3$)
						tons/1000 tons						
1N-1019R	0.55	0.09	0.07	0.30	0.09	23.2	17.3	5.9	11.2	12	0.0	17
1N-1039	0.53	0.11	0.01	0.33	0.08	<1.0	16.69	-16.69	10.69	-10.69	1.0	18
1N-1019	0.56	0.08	0.08	0.31	0.09	23.2	17.6	5.6	11.7	11.5	0.0	18
1N-1016	0.52	0.09	0.09	0.33	0.01	3.1	16.4	-13.3	12.4	-9.3	1.8	18
1N-1059	1.17	0.63	0.11	0.30	0.14	12.46	36.56	-24.1	11.85	0.61	0.0	20
1S-1028	0.53	0.11	0.12	0.22	0.08	<1.0	16.66	-16.66	9.74	-9.74	3.9	20
1S-1058	0.64	0.1	0.05	0.32	0.17	7.44	20	-12.56	11.2	-3.76	0.0	21
1N-1025	1.29	0.78	0.09	0.39	0.03	<1.0	40.31	-40.31	14.1	-14.1	3.2	23
1S-1070	0.64	0.08	0.15	0.31	0.11	<1.0	20.03	-20.03	13.02	-13.02	6.1	28
1N-1077	0.87	0.09	0.07	0.48	0.23	28.75	27.03	1.71	16.45	12.3	0.0	30
1N-1046	0.75	0.14	0.02	0.42	0.17	<1.0	23.38	-23.38	13.54	-13.54	6.0	31
1N-1033	0.91	0.09	0.08	0.51	0.23	17.45	28.41	-10.96	17.79	-0.34	0.0	31
1S-1051	0.86	0.12	0.09	0.54	0.11	<1.0	26.88	-26.88	18.99	-18.99	6.1	36
1S-1061	0.74	0.13	0.12	0.24	0.25	<1.0	23.16	-23.16	10.4	-10.4	10.4	36
1N-1006	1.14	0.15	0.01	0.83	0.15	<1.0	35.6	-35.6	26.3	-26.3	3.1	42
1S-1075	1.28	0.11	0.16	0.68	0.33	22.28	40	-17.72	24.88	-2.6	5.3	51
1S-1032	1.73	0.25	0.01 u	1.46	0.08	5.02	54.06	-49.05	45.74	-40.72	0.0	60
1N-1010	3.34	0.74	0.01 u	2.22	0.51	1.87	104.38	-102.5	69.34	-67.47	5.3	114
1N-1081	6.08	0.85	0.01 u	4.88	0.47	5.01	190	-185	152.38	-147.4	3.2	213
1N-1064	6.22	0.24	0.01 u	5.98	0.36	10.03	194.38	-184.3	187	-177	0.3	248

Notes: u = undetectable at this value.

APPENDIX H

CHANNEL AND STREAMBANKS RECONSTRUCTION DATA

Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

Appendix H

Channel and Streambank Reconstruction

H-1 Channel and Streambanks

Technical Memo and Associated Calculations: Terrace Design and Floodplain Shear

Technical Memo and Associated Calculations: Bed Material Gradation and Scour Depth Analysis for Regulated Flow Channel

Technical Memo and Associated Calculations: Bank Toe Design for Non-Deformable Channel

Technical Memo and Associated Calculations: Critical Low Flow Discharge for Deformable Channel

Technical Memo and Associated Calculations: Determination of Bank Treatment Types, Inside and Outside Bends for Deformable Channel

HEC-RAS Output for Sediment Continuity Analysis (Conceptual Design Report, Inter-Fluve and Mussetter Engineering, 1998).

HEC-RAS Output and Input for Proposed Channel and Floodplain Conditions, Reach A

H-2 County Road Crossing

Technical Memo and Associated Calculations: Culvert Design at County Road Crossing

Technical Memo and Associated Calculations: Reconstruction of County Road

APPENDIX H-1

Channel and Streambanks

INTER-FLUVE, INC.

25 N. WILLSON AVE.
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MEMORANDUM

To: ***Silver Bow Creek SSTOU, SubArea 1, Reach A***
From: ***Martin Doyle***
Date: ***4/7/98***
In Regards To: ***Terrace design and Floodplain Shear***

The actual floodplain design (the outward slope from the channel) was determined by MEI and will not be re-discussed. We modeled numerous flows over the floodplain (2, 5, 10, 20, 50-yr events) in order to establish the stability of the floodplain during high flows. The highest shears present on the floodplain were found to be 0.34 lb/ft^2. These shears were only present for short distances along the most constricted portions of the floodplain.

Further, terraces were designed along the floodplain according to the design criteria of the PFDR. In support of the terrace design and its fulfillment of the hydraulic design criteria, I have included a summary of the hydraulic analysis we conducted on the affects of placing terraces along the floodplain:

In response to our meeting on 2/3/98 regarding the design of terraces, I placed one terrace on the existing HEC-RAS model of Silver Bow Creek in order to observe the effects of the terrace on the floodplain hydraulics. The terrace was placed on the left side of the floodplain (facing downstream), extended to within 50 feet of the channel at cross-section 908 and to within 100 feet of the channel at cross-section 907 (see attached HEC diagram). The terrace height was varied from 6 to 24 inches, and was modeled using the 5, 10, 20, and 50-yr flows for each of the terrace heights. The terrace was located near the downstream end of Reach A where there are no backwater effects from near-by bridges or culverts.

I have attached 3 sheets summarizing the results of the HEC-RAS modeling of the terraces. On each sheet, the first set of numbers gives the values for the proposed conditions of the floodplain with no terraces. Below this, I give the results of the floodplain with no terraces minus the results of the floodplain with terraces of varying height. This is to facilitate comparison. Cross-sections 907 and 908 are shaded in order to indicate where the terrace is actually located. In each case, a positive number indicates that the terrace has caused a decrease in the value and a negative number indicates that the terrace has caused an increase in the value.

Summary: the 6 inch terrace had no effect on in-channel or floodplain hydraulics. The other terraces had minimal effect on the 5-yr and 10-yr flow, but started becoming significant during the 20 and 50-yr flows. There was minimal effect of the terraces on the in-channel hydraulics (Sheet A) or on the hydraulics of the right side of the floodplain. However, there were significant effects on the left-side of the floodplain at cross-section 908 and little effect at cross-section 907. This is thought to be because cross-section 908 extends to within 50 feet of the channel, causing convergent flow and increased velocities and shears.

Sheet A gives the results for the velocity and shears in the channel. The results indicate that terraces have some impact on in-channel hydraulics. However, these changes are all fairly small (< 0.07% change from no terrace conditions). The largest impact on shears occurs during the 50-yr flow for all terrace heights (except for the 6 inch terrace in which there is no change). The maximum impact of the terraces was that they lowered in-channel shears from 0.64 to 0.60 lb/ft^2, a 6% decrease. The greatest impact on in-channel velocity was by the inclusion of a 12 inch terrace during the 50-yr flow. This terrace caused an increase of the in-channel velocity from 5.99 to 6.23 ft/sec, a 4% increase.

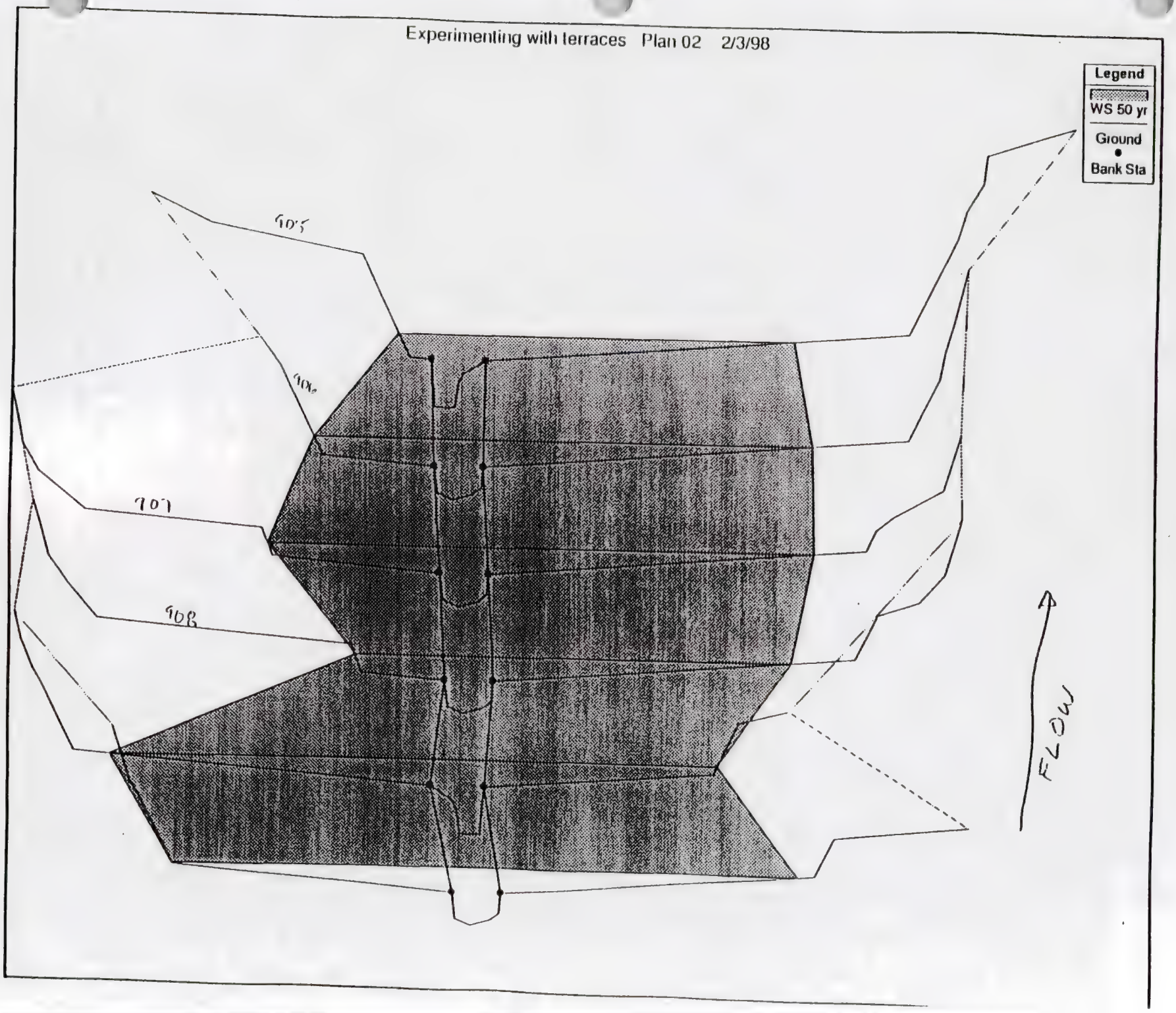
Sheet B gives the results of the shear values for the floodplain area: Right Over Bank (ROB) and Left Over Bank (LOB). The inclusion of terraces had a large impact on the floodplain shears, especially for the 18 and 24 inch terraces. For the 20-yr flow, the 12, 18 and 24 inch terraces increased the shear on the left floodplain at cross-section 908 from 0.18 to 0.26 lb/ft^2, a 44% increase. The 18 and 24 inch terraces increased the left floodplain shears during the 50-yr flow from 0.19 to 0.34 lb/ft^2 (79% change), and the 12 inch terrace increased the left floodplain shears from 0.19 to 0.25 lb/ft^2 (32% change). It should be noted that all of these larger changes in shears occurred at cross-section 908, and that only negligible changes occurred at cross-section 907.

Sheet C gives the results of the velocity values for the floodplain area: Left and Right. The inclusion of 12, 18 and 24 inch terraces had a large impact on the left floodplain hydraulics at cross-section 908. The velocity in these cases increased from 1.25 to 1.64 ft/sec (31% change) for the 20-yr flow and increased from 1.34 to 1.95 ft/sec (46% change) for the 50-yr flow. While increases in the floodplain velocities at cross-section 908 were frequently large, the only significant increase at cross-section 907 was for all terrace heights during the 50-yr flow. The terrace at this location caused an increase in the left floodplain velocity to increase from 1.36 to 1.58 ft/sec (16% change).

***Recommendations:** Based on the results of the model runs, the construction of terraces has the ability to greatly increase floodplain velocities and shears if constructed too large or too close to the channel. The lowering of floodplain velocities and shears upstream of the terraces was not noticed. This is most likely due to the relatively large spacing of cross-sections (100 ft) which would not have allowed for the accurate modeling of such changes. The greatest affects of terraces were obtained when the flows could not overtop the terraces and when the terraces extended far into the floodplain (e.g. XS 908). The terrace extension into the floodplain, and thus the contraction of flow to a smaller area is thought to be one of the more dominant factors in floodplain hydraulics. It appears that the terrace distance at cross-section 908 (50 ft) is too small.*

Rather than set a definite design for floodplain terraces, a maximum value for floodplain shear and velocity should be set. Given these guidelines, terraces will be added to the

proposed floodplain with a maximum height of 12 inches, and a minimum distance from the channel of 75 feet. The model will then be run to assure that the new velocities and shears on the floodplain do not exceed those set. The terrace dimensions will then be altered until these conditions are met.


Experimenting with terraces Plan 02 2/3/98
Legend
WS 50 yr
Ground
Bank Sta
105
106
107
108
FLOW

if > 0, terrace decreased shear

if < 0, terrace increased shear

if > 0, terrace slowed flow down

if < 0, terrace sped flow up

	River Sta	5-yr Shear Chan (lb/sq ft)	5-yr Vel Chnl (ft/s)	10-yr Shear Chan (lb/sq ft)	10-yr Vel Chnl (ft/s)	20-yr Shear Chan (lb/sq ft)	20-yr Vel Chnl (ft/s)	50-yr Shear Chan (lb/sq ft)	50-yr Vel Chnl (ft/s)
No Terrace HEC-RAS Results	914	0.49	4.4	0.54	4.69	0.55	4.82	0.58	5.04
	913	0.59	4.84	0.66	5.21	0.71	5.5	0.77	5.83
	912	0.51	4.46	0.6	4.94	0.68	5.35	0.8	5.9
	911	0.47	4.31	0.52	4.62	0.58	4.93	0.68	5.43
	910	0.59	4.83	0.64	5.17	0.68	5.4	0.71	5.6
	909	0.48	4.34	0.5	4.55	0.5	4.59	0.51	4.75
	908	0.56	4.73	0.68	5.3	0.77	5.73	0.81	5.89
	907	0.56	4.74	0.59	4.97	0.6	5.07	0.64	5.34
	906	0.55	4.7	0.57	4.87	0.58	5.01	0.61	5.23
	914	0	0	0	0	0	0	0	0
	913	0	0	0	0	0	0	0	0
	912	0	0	0	0	0	0	0	0
	911	0	0	0	0	0	0	0	0
	910	0	0	0	0	0	0	0	0
	909	0	0	0	0	0	0	0	0
No Terrace Minus 6"	908	0	0	0	0	0	0	0	0
	907	0	0	0	0	0	0	0	0
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0
	914	0	0	0.01	0.01	0	0	0	0
	913	0	0	0	0	0	-0.01	0	0
	912	0	0	0	0	0	0	0	0.01
	911	0	0	0	0	0	-0.01	0	0.01
	910	0	0	-0.01	-0.04	-0.02	-0.05	0.02	0.08
	909	0	0	-0.02	-0.07	-0.02	-0.1	0.02	0.09
No Terrace Minus [illegible]	908	0	0	0.02	0.08	0.03	0.13	-0.07	-0.24
	907	0	0	0	0	0.01	0.02	0.04	0.17
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0
	904	0	0	0	0	0	0	0	0
	914	0	0	0.01	0.01	0	0	0	0
	913	0	0	0	0	0	-0.01	0	0
	912	0	0	0	0	0	0	-0.01	0
	911	0	0	0	0	0	-0.01	0	-0.01
	910	0	0	-0.01	-0.04	-0.02	-0.05	0	-0.02
	909	0	0	-0.02	-0.07	-0.02	-0.1	-0.01	-0.03
No Terrace Minus 18"	908	0	0	0.02	0.08	0.03	0.13	-0.01	-0.03
	907	0	0	0	0	0.01	0.02	0.04	0.17
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0
	904	0	0	0	0	0	0	0	0
	914	0	0	0.01	0.01	0	0	0	0
	913	0	0	0	0	0	-0.01	0	0
	912	0	0	0	0	0	0	-0.01	0
	911	0	0	0	0	0	-0.01	0	-0.01
	910	0	0	-0.01	-0.04	-0.02	-0.05	0	-0.02
	909	0	0	-0.02	-0.07	-0.02	-0.1	-0.01	-0.03
No Terrace Minus 24"	908	0	0	0.02	0.08	0.03	0.13	-0.01	-0.03
	907	0	0	0	0	0.01	0.02	0.04	0.17
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0

decreased shear increased shear

	River Sta	5-yr Shear LOB (lb/sq ft)	5-yr Shear ROB (lb/sq ft)	10-yr Shear LOB (lb/sq ft)	10-yr Shear ROB (lb/sq ft)	20-yr Shear LOB (lb/sq ft)	20-yr Shear ROB (lb/sq ft)	50-yr Shear LOB (lb/sq ft)	50-yr Shear ROB (lb/sq ft)
No Terrace HEC-RAS Results	914	0.08	0.08	0.14	0.11	0.18	0.15	0.23	0.2
	913	0.11	0.09	0.19	0.13	0.24	0.16	0.31	0.2
	912	0.12	0.08	0.19	0.12	0.26	0.16	0.34	0.21
	911	0.09	0.08	0.15	0.11	0.2	0.14	0.27	0.18
	910	0.09	0.09	0.13	0.13	0.15	0.15	0.19	0.18
	909	0.08	0.08	0.11	0.11	0.12	0.14	0.14	0.18
	908	0.12	0.09	0.16	0.13	0.18	0.17	0.19	0.21
	907	0.09	0.09	0.14	0.12	0.18	0.14	0.18	0.17
	906	0.1	0.09	0.17	0.12	0.21	0.14	0.26	0.16
	914	0	0	0	0	0	0	0	0
	913	0	0	0	0	0	0	0	0
	912	0	0	0	0	0	0	0	0
	911	0	0	0	0	0	0	0	0
	910	0	0	0	0	0	0	0	0
	909	0	0	0	0	0	0	0	0
No Terrace Minus 6"	908	0	0	0	0	0	0	0	0
	907	0	0	0	0	0	0	0	0
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0
	914	0	0	0	0	0	0	0	0
	913	0	0	0	0	0	0	0	0
	912	0	0	0	0	0	0	0	0
	911	0	0	0	0	0	0	0	0
	910	0	0	0	0	-0.01	-0.01	0	0
	909	0	0	0	0	-0.01	0	0	0
No Terrace Minus 12"	908	0	0	-0.04	0	-0.08	0.01	-0.06	-0.01
	907	0	0	0	0	0	0	-0.05	0.01
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0
	904	0	0	0	0	0	0	0	0
	914	0	0	0	0	0	0	0	0
	913	0	0	0	0	0	0	0	0
	912	0	0	0	0	0	0	-0.01	0
	911	0	0	0	0	0	0	0	0
	910	0	0	0	0	-0.01	-0.01	0	0
	909	0	0	0	0	-0.01	0	0	0
No Terrace Minus 18"	908	0	0	-0.04	0	-0.08	0.01	-0.15	0
	907	0	0	0	0	0	0	-0.05	0.01
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0
	904	0	0	0	0	0	0	0	0
	914	0	0	0	0	0	0	0	0
	913	0	0	0	0	0	0	0	0
	912	0	0	0	0	0	0	-0.01	0
	911	0	0	0	0	0	0	0	0
	910	0	0	0	0	-0.01	-0.01	0	0
	909	0	0	0	0	-0.01	0	0	0
No Terrace Minus 24"	908	0	0	-0.04	0	-0.08	0.01	-0.15	0
	907	0	0	0	0	0	0	-0.05	0.01
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0

slowed flow down sped flow up

	River Sta	5-yr Vel Left (ft/s)	5-yr Vel Right (ft/s)	10-yr Vel Left (ft/s)	10-yr Vel Right (ft/s)	20-yr Vel Left (ft/s)	20-yr Vel Right (ft/s)	50-yr Vel Left (ft/s)	50-yr Vel Right (ft/s)
No Terrace HEC-RAS Results	914	0.78	0.78	1.1	0.97	1.33	1.16	1.58	1.44
	913	0.92	0.8	1.31	1.02	1.57	1.18	1.86	1.37
	912	0.99	0.78	1.36	1.01	1.63	1.18	1.95	1.4
	911	0.83	0.77	1.18	0.96	1.42	1.11	1.72	1.3
	910	0.81	0.81	1.02	1.02	1.16	1.16	1.35	1.31
	909	0.78	0.78	0.96	0.96	1.05	1.15	1.17	1.39
	908	0.99	0.8	1.18	1.05	1.25	1.23	1.34	1.4
	907	0.8	0.8	1.1	0.99	1.32	1.11	1.36	1.27
	906	0.9	0.8	1.26	0.99	1.47	1.11	1.71	1.26
	914	0	0	0	0	0	0	0	0
	913	0	0	0	0	0	0	0	0
	912	0	0	0	0	0	0	0	0
	911	0	0	0	0	0	0	0	0
	910	0	0	0	0	0	0	0	0
	909	0	0	0	0	0	0	0	0
No Terrace Minus 6"	908	0	0	0	0	0	0	0	0
	907	0	0	0	0	0	0	0	0
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0
	914	0	0	0	0	0	0	0	0
	913	0	0	0	0	0	0	0	0
	912	0	0	0	0	0	0	0	0
	911	0	0	0	0	0	0	0	0
	910	0	0	0	0	-0.01	-0.01	0	0.02
	909	0	0	0	0	-0.02	0	0.02	0.02
o Terrace Minus	908	0	0	-0.19	0.02	-0.39	0.03	-0.24	-0.05
	907	0	0	0	0	-0.02	0	-0.22	0.04
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0
	904	0	0	0	0	0	0	0	0
	914	0	0	0	0	0	0	0	0
	913	0	0	0	0	0	0	0	0
	912	0	0	0	0	0	0	-0.01	0
	911	0	0	0	0	0	0	-0.01	-0.01
	910	0	0	0	0	-0.01	-0.01	0	0
	909	0	0	0	0	-0.02	0	-0.01	0
No Terrace Minus 18"	908	0	0	-0.19	0.02	-0.39	0.03	-0.61	0
	907	0	0	0	0	-0.02	0	-0.22	0.04
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0
	904	0	0	0	0	0	0	0	0
	914	0	0	0	0	0	0	0	0
	913	0	0	0	0	0	0	0	0
	912	0	0	0	0	0	0	-0.01	0
	911	0	0	0	0	0	0	-0.01	-0.01
	910	0	0	0	0	-0.01	-0.01	0	0
	909	0	0	0	0	-0.02	0	-0.01	0
No Terrace Minus 24"	908	0	0	-0.19	0.02	-0.39	0.03	-0.61	0
	907	0	0	0	0	-0.02	0	-0.22	0.04
	906	0	0	0	0	0	0	0	0
	905	0	0	0	0	0	0	0	0

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MEMORANDUM

To: *Silver Bow Creek, SSTOU, SubArea 1, Reach A Design*
From: *Martin Doyle*
Date: *2/18/98*
In Regards To: *Bed Material Gradation and Depth of Scour Analysis for Regulated Flow Channel*

Below, I describe the assumptions and methods I used in calculating the bed material size required for Reach A, and the depth to which scour should be expected using this gradation size.

For both sets of analyses I used the HEC-RAS deck which models the conditions of the proposed channel alignment and floodplain. The design criteria establishes that the regulated flow channel should be designed for a 50 cfs flow.

Maximum shear stresses throughout Reach A were consistently associated with riffle areas. This is shown by high shear cross-sections corresponding with low flow depths and high velocities. Typical cross-sections which show the riffle pool sequence (and associated values of shears, depths, and velocities) are HEC XS's 937 & 936, 919 & 918, 913 & 912, 910 & 909, and 906 & 905 (see attached spreadsheet printout).

INCIPIENT MOTION ANALYSIS

The incipient motion analyses were carried out for two conditions, pool/run cross-sections and riffle cross-sections. The riffle cross-section conditions were based on the typical values of those riffle sections mentioned in the paragraph above. Pool/run conditions were based on pool section conditions and typical values for sections other than riffles.

The table below shows a wide range of results in the mobile grain sizes under the given conditions. It should be noted that the Energy Grade Slope was assumed constant for both section conditions (set equal to 0.0034). This is the average bed slope of the reach, and is thus thought to give an average value of for the entire reach (for pools, riffles and runs). Based on the results below, the D_{50} of the riffles should be approximately 3.0 inches and the D_{50} of the pools and runs should be approximately 1.5 inches (based on interpretation and judgement of the results given below). If these ranges are considered appropriate, the gradation of bed material used at the pilot test could be used. The gradation is

considered appropriate for the regulated flow channel due to the fact that it is approximately the correct size for the pool/run sections (1.5 inches), and if it is assumed that the riffle sections will become armored, then the pilot test gradation will most likely become coarser.

Gradation of bed material used at Silver Bow Pilot Test

Sieve size (inches)	*Percent Passing*
3.5	100
2.0	84
1.5	53
1.0	30
0.75	5

Variables and results for pool/run and riffle cross-section incipient motion analyses

Variables	*Pool/Run*	*Riffle*
Hydraulic Radius	1.8	0.8
Shear	0.2	0.8
Depth (local)	1.8	0.8
Energy Gradient	0.0034	0.0034
Velocity	2	4
*Results (inches)**		
FHWA Energy Slope	1.93	1.93
FHWA Shear	1.01	4.04
ACOE	0.40	3.09

* All of these methods are described in Simons and Senturk (1992)

DEPTH OF SCOUR ANALYSIS

Based on the HEC-RAS deck described above, and the gradation found above, the depth of scour expected along the channel (not associated with the culvert or any bridge piers) was found to be approximately 1 ft. The table below gives the results of the analysis (values used in analysis can be found in calculation sheets). Included in the analysis, but not shown below, was the analysis of 'sill scour.' The idea being that flow from a riffle to a pool (higher to lower elevation) will be accelerated similar to flow going over a sill or low-drop type structure. The analysis (based on three methods found in Simons and Senturk) showed that there would be no additional scour due to the vertical drop in flow. Hence, all scour in the channel should be associated with meander bends only (excluding local effects of the culvert and bridge piers).

Depth of scour results and channel bends

Method	*Depth of scour predicted below channel thalweg (ft)*
Watanabe et al. [a]	1.0
Maynord [a]	1.1
Neill [b]	0.6 [c]
Lacey [b]	0.6 [c]

[a] Method taken from Simons and Senturk (1992)

[b] Method taken from methodology of Bureau of Reclamation "Computing Degradation and Local Scour (1984)"

[c] Results for "Severe Bends" (worst case)

(Note: This sheet is for calculating incipient motion particle size on the streambed, not the banks)

Project: Silver Bow Creek, SSTOU SubArea 1, Reach A
Name: M. Doyle
Date: 4/3/98

Pool/Run Gradations

Needed for method:	Parameter			units	Generally assumed to be
12	Shield's Parameter (0.03 for gravel bed, 0.047 for san		0.03		0.047
	Hydraulic Radius		1.8	ft	
2	Shear Stress		0.2	lb/ft^2	
1	Depth (average		1.8	ft	
4	Depth (local)		1.8	ft	
1234	Specific Gravity of Rock Ripra		2.65		2.65
123	Unit Weight of Sedimen		165.4	lb/ft^3	165.4
1234	Unit Weight of Water		62.4	lb/ft^3	62.4
1234	Slope Angle (side slope with horizontal	Disregard these rows	21.8	degrees	
1234	Angle of Repose		36	degrees	
1	Energy Gradien		0.0034	ft/ft	
34	Velocity (average		2	ft/sec	
4	Bend Radius of Curvatur		120	ft	
4	Width of Water Surface		16	ft	
4	Enter 1 if trapezoidal channel, 2 if natur		2		
4	Enter 1 if straight channel or outside bend with r/w>2 or enter 2 if outside bend with r/w<2		2		
1234	Gravitational Constan		32.2	ft/sec^2	32.2
4	Stability Coefficient	(0.3 for angular rock and 0.36 for round	0.36		
124	Safety Factor		1.3		

1.0 to 1.2	Uniform flow, straight to mildly curving, r/w > 30, wave and debris impact minimal, no uncertainty in parameters
1.3 to 1.6	Gradually varying flow, moderate bed 10<r/w<30 wave and debris impact moderate
1.6 to 2.0	Approaching rapidly varying flow, sharp bend r/w < 10 significant impact, high turbulence, uncertainty in parameters

Output		ft	inches	mm		# of paramters	Check
1. FHWA Energy Slope Method	D50	0.16	1.93	48.99		10	Data OK
2. FHWA Shear Method	D50	0.08	1.01	25.65		9	Data OK
3. Isbash Velocity Method	D50	0.03	0.34	8.58	disregard	7	Data OK
4. ACOE	D30	0.03	0.40	10.07		13	Data OK

(Note: This sheet is for calculating incipient motion particle size on the streambed, not the banks)

Project: Silver Bow Creek, SSTOU SubAres 1, Reach A — Riffle Gradations
Name: M. Doyle
Date: 4/3/98

Needed for method:	Parameter			units	Generally assumed to be
12	Shield's Parameter (0.03 for gravel bed, 0.047 for sand		0.03		0.047
	Hydraulic Radius		0.8	ft	
2	Shear Stress		0.8	lb/ft^2	
1	Depth (average		1.8	ft	
4	Depth (local)		0.8	ft	
1234	Specific Gravity of Rock Riprap		2.65		2.65
123	Unit Weight of Sediment		165.4	lb/ft^3	165.4
1234	Unit Weight of Water		62.4	lb/ft^3	62.4
1234	Slope Angle (side slope with horizontal)	Disregard these rows	21.8	degrees	
1234	Angle of Repose		35	degrees	
1	Energy Gradient		0.0034	ft/ft	
34	Velocity (average		4	ft/sec	
4	Bend Radius of Curvature		120	ft	
4	Width of Water Surface		27	ft	
4	Enter 1 if trapezoidal channel, 2 if natural		2		
4	Enter 1 if straight channel or outside bend with r/w>2 or enter 2 if outside bend with r/w<2		1		
1234	Gravitational Constan		32.2	ft/sec^2	32.2
4	Stability Coefficient	(0.3 for angular rock and 0.36 for round	0.36		
124	Safety Factor		1.3		

1.0 to 1.2	Uniform flow, straight to mildly curving, r/w > 30, wave and debris impact minimal, no uncertainty in parameters
1.3 to 1.6	Gradually varying flow, moderate bed 10<r/w<30 wave and debris impact moderate
1.6 to 2.0	Approaching rapidly varying flow, sharp bend r/w < 10 significant impact, high turbulence, uncertainty in parameters

Output		ft	inches	mm		# of paramters	Check
1. FHWA Energy Slope Method	D50	0.16	1.93	48.99		10	Data OK
2. FHWA Shear Method	D50	0.34	4.04	102.59		9	Data OK
3. Isbash Velocity Method	D50	0.11	1.35	34.30	disregard	7	Data OK
4. ACOE	D30	0.26	3.09	78.47		13	Data OK

GENERAL/CONSTRICTION SCOUR COMPUTATIONS

Based on: B.O.R. Methodolog "Computing Degradation and Local Scour" 1984

Stream/River:	Silver Bow Creek	Engineer:	M. Doyle
Cross-section:	Reach A	Date:	2/18/98
Notes:			

df = scoured depth below designed floodwater level
di = average depth at bankfull discharge in incised reach (reach which "spills" only at high Q)
qf = designed flood discharge per unit width
qi = bankfull discharge per unit width in incised reach (reach which "spills" only at high Q)
m = exponent 0.67 for sand, 0.85 for gravel

di =	2.6	ft.	qf =	1.85
bank full top width =	30	ft.	qi =	6.67
design flow top width =	27	ft		
design discharge =	50	cfs		
bankfull discharge =	200	cfs		
m =	0.85			

Neill Equation

Uses field measurements from "incised" reach

df = di * (qf/qi)^m

df = 0.88 ft

Lacey Equation

Includes empirical regime equation by Lacey, and method of zero bed-sediment transport by Blench.

dm = 0.47*(Q/f)^(1/3)

dm = mean depth at design discharge (ft.)
Q = design discharge (cfs)
f = silt factor f = 1.76*(Dm)^0.5
Dm = mean grain size of bed materials in mm

range:

D(50) = 1.5 inches = 38.1 mm

dm = 0.78 ft

GENERAL/CONSTRICTION SCOUR COMPUTATIONS Page 2/3

Blench Equation

Dfo = qf^(2/3)/Fbo^(1/3)

Dfo = depth for zero bed sediment transport (ft.)
gf = design flood discharge per unit width (cfs/ft)
Fbo = Blench's zero bed factor (ft/s^2)

Don't use Blench

for above D(50):
Fbo (from figure 9) = 5.5 ft/s^2

Dfo = 0.85 ft

Depth of Scour

ds = Zn*df
ds = Zl*dm
ds = Zb*dfo

ds = depth of scour below streambed
Zn = Neill, empirically developed multiplication factor
Zl = Lacey, empirically developed multiplication factor
Zb = Blench, empirically developed multiplication factor

General/Constriction Scour		Bend Scour*			
Multiplication factor	Straight reach	Moderate bend	Severe bend	Right angle bend	Vertical wall
Zn	0.5	0.6	0.7		
Zl	0.25	0.5	0.75	1	1.25
Zb	0.6	0.6	0.6	1.25	

Local Scour*	
Multiplication factor	Nose of pier
Zn	1
Zl	
Zb	1

Spur Scour*
Nose of spur dikes
0.7
1.75
1.75

Weir Scour*
Grade control or small dam
1.5
1.25

* Use these for rough calculations only, equations specific to these scour types should be used for more accuracy

GENERAL/CONSTRICTION SCOUR COMPUTATIONS Page 3/3

PREDICTED SCOUR DEPTHS (FT)

Equation	Straight reach	Moderate bend	Severe bend*	Right angle bend	Vertical wall*
Neill ds =	0.4	0.5	0.6		
Lacey ds =	0.2	0.4	0.6	0.8	1.0
Blench ds =					
ds (average) =	**0.3**	**0.5**	**0.6**	**0.8**	**1.0**

Equation	Nose of pier*		Nose of spur dikes*		Grade control or small dam*
Neill ds =	0.9		0.6		
Lacey ds =			1.4		1.2
Blench ds =					
ds (average) =	**0.9**		**1.0**		**1.2**

* Use these for rough calculations only, equations specific to these scour types should be used for more accuracy

BEND SCOUR COMPUTATIONS

Based on: Maynord (1996)

Stream/River:	Silver Bow	Engineer:	M. Doyle
Cross-section:	Reach A	Date:	2/18/98
Notes:			

Method 1: Watanabe et al. (1990)

Input variables

27	= W = Flow top width (ft)
1	= D(upstr) = Mean water depth upstream of bend (ft)
0.0034	= S = Slope
120	= R = Centerline radius of bend
0.027	= f = Darcy friction factor
3.3	= d(ave) = average depth of pool cross-section
3.5	= d(max) = thalweg depth in pool

Recommended factor of safety is 1.2

Computations

Sigma = arctan(1.5*f((1.11/f^0.5 - 1.42)	Sigma =	0.212806
Ex = 1/1.5*f(1.11/f^0.5 - 1.42)*sin(sigma) + cos(sigma)	Ex =	0.977442
Beta = 2/pi*1.226(1/f^0.5-1.584)*Ex	Beta =	3.436123
Big Ex = log(WS^0.2/D(upstr))	Big Ex =	0.93766
Alpha = 0.361*Big Ex^2 - 0.0224*Big Ex - 0.0394	Alpha =	0.25699

n = depth of scour below average bed surface

n = D(upstr) * (alpha + beta*(W/R)) * 1.2

n =	1.2	ft
ds =	1.0	ft
	below thalweg	

Method 2: Maynord (1996)

Input variables

Method 2 uses f, R, W, and D(mean) from above as well as the following:

Recommended factor of safety is 1.1 - 1.2

Equation should only be applied when overbank depth is less than 20% of main-channel depth.

Method 2: Maynord (1996) continued

Computations

1. R/W = 4.4

Application of this equation is limited to R/W between 1.5 and 10.
If R/W < 10, use R/W of 1.5.

Enter R/W here: 4.4

2. W/D(upstr) = 27.0

Application of this equation is limited to W/D(upstr) between 20 and 125
If W/D(upstr) < 20, use W/D(upstr) = 20.

Enter W/D(upstr): 27.0

3. D(max) = maximum water depth in bend

$$D(max) = D(upstr) * [1.8 - 0.051(R/W) + 0.0084(W/D(upstr)]$$

D(max) = 1.8 ft

4. Include factor of safety

FS	D(max)	ds*
1.1	2.0	1.0
1.2	2.2	1.2

* ds = D(max) - D(upstr)

3. Average of Methods 1 and 2:

(Use FS = 1.2 for Method 2)

Method	ds (ft)
1	1.0
2	1.2
Average	**1.1**

SILL SCOUR COMPUTATIONS

Schoklitsch, Eggenburger, and Jager, Methods 1,2, and 3, are from Simons and Senturck (1992)
Levi, Method 4, from Przedwojski, Blazejewski, and Pilarczyk

Stream/River:	Silver Bow Creek	Engineer:	M. Doyle
Cross-section:	Reach A	Date:	2/18/98
Notes:			

Method 1: Schoklitsch (1932)

Q (cfs)	Q(cms)	FT	M	
50	1.42	0.07		0.02

Input variables **All variables in metric**

50.8	= D_{90} = Particle size for which 90 percent of the material is finer (mm).
1.42	= Q = Water discharge (cms).
9.14	= W = Channel width at scour location (m).
0.2	= q = Water discharge per unit of width.
0.02	= H = Vertical distance between the energy grade line and the downstream water surface (m).
0.61	= hd = Downstream water depth (m).

S = Depth of the scour hole.
ds = distance between bottom of scour hole and downstream water surface.

Computations

4.75 * (H^.2*q^.5)/(D90^.32)	ds =	0.2
ds-hd=S	S =	-0.4

Method 2: Eggenberger (1943)

Input variables **All variables in metric**

(This method better for larger bed material)
(Does not account for live bed/sed transport)

Same as above.

Computations

22.8 * (H^.5*q^.6)/(D90^.4)	ds =	0.2
ds-hd=S	S =	-0.4

Method 3: Jager (1939)

Input variables **All variables in metric**

Same as above.

Computations

6 * (H^.25)*(q^.5)*(hd/D90)^.33	ds =	0.2
ds-hd=S	S =	-0.4

Method 4: Levi (1950's)

Input variables **All variables in metric**

0.13	= D = Mean diameter of uniform bed material (m).
0.61	= ho = Initial water depth (same as hd).
1.42	= Qbf = Design water discharge, approximately bank full.
9.14	= B = Width of the scoured cross-section.

Uc = Mean critical (threshold) velocity of flow.
h1 = distance between bottom of scour hole and initial water depth (same as ds).

Computations

Uc = 1.7 * (gD)^.5 (ho/D)^.2	Uc =	2.6 m/s
h1 = Qbf / (B Uc)	h1 =	0.06
S = h1-ho	S =	-0.55

Comparison of Methods:

Method	S (metric)
1	-0.4
2	-0.4
3	-0.4
4	-0.6
Average	**-0.4**

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MEMORANDUM

To: ***Silver Bow SSTOU, SubArea 1, Reach A***
From: ***Martin Doyle***
Date: ***4/3/98***
In Regards To: ***Bank toe design for non-deformable channel***

Calculation sheets for each section are attached.

1. Incipient Motion/Rock Sizing: Using the methods suggested by the Federal Highway Administration for sizing Riprap revetment, the first attached sheet shows the assumptions and results of the analysis. The assumptions were based on sizing rock capable of not moving at the 100-yr flow (2330 cfs). Based on all of these methods, I determined that the rock to be used should have a **D50 of 9 inches.** The Army Corps of Engineers method was not used as it is generally used for reaches with bends. As this is an extremely straight reach (sinuosity ~1.0), the ACOE method was not used. The gradation for the material was based on a D50 value of 9 inches, and is given by

Stone size in inches	*Percent of gradation finer than*
13.5 to 15.3	100
10.8 to 12.6	85
9.0 to 10.4	50
3.6 to 5.4	15

This stone type is larger than any of those previously mentioned, and should be added to the technical specifications.

2. Depth of Scour: Using the gradation as described above, the design methods of the Bureau of Reclamation (Computing Degradation and Local Scour, 1984), and hydraulic characteristics of the 100-yr flow (determined through HEC-RAS), three depths of scour were determined (three design methods). There was a large range of values in the methods and thus the results require a certain degree of interpretation. The Neill and Blench methods predicted scour depths of 3.9 and 3.7 ft respectively. The Lacey method predicted a scour depth of 0.7 ft. The Neill method was designed for "incised" reaches and is thus expected to over-predict the actual amount of scour. I have found that the Lacey method consistently predicts the lowest amount of scour. I am not too familiar with the

Blench method. Based on my interpretation of these results, I recommend that a **scour depth of 3.5 ft be used.** Although this is under 2 of the 3 methods (but much higher than the third), I feel that it is a conservative and substantiated estimate.

3. **Gravel Filter Design:** Based on the size of stone recommended for toe protection earlier, and the size of soil at the construction site (estimated through soil pit data), I used the Federal Highway Administration Design of Riprap Revetment to design the filter. Based on the equations provided for gravel filter design, it was determined that a filter of the following size would be sufficient:

Stone size in inches	*Percent of gradation finer than*
1.25	100
1.0	85
No. 4	50
No. 20	15

It should be noted that not all conditions were satisfied using this filter, however using a two-layer filter is not practical, and this one fulfills all but one filter condition (see attached sheet).

Project: Silver Bow Creek, SSTOU SubArea 1, Reach A upstream 1200 ft
Name: Martin Doyle
Date: 2-Apr-98

INCIPIENT MOTION ANALYSIS

Needed for method:	Parameter			units	Generally assumed to be
12	Shield's Paramter		0.047		0.047
	Hydraulic Radius		6.87	ft	
2	Shear Stress		2	lb/ft^2	
1	Depth (average		7.6	ft	
4	Depth (local)		8.2	ft	
1234	Specific Gravity of Rock Riprap		2.65		2.65
123	Unit Weight of Sediment		165.4	lb/ft^3	165.4
1234	Unit Weight of Water		62.4	lb/ft^3	62.4
1234	Slope Angle (side slope with horizonta		26.5	degrees	
1234	Angle of Reposc		45	degrees	
1	Energy Gradien		0.005	ft/ft	
34	Velocity (average		10	ft/sec	
4	Bend Radius of Curvatur			ft	
4	Width of Water Surface		80	ft	
4	Enter 1 if trapezoidal channel, 2 if natur		2		
4	Enter 1 if straight channel or outside bend with r/w>2 or enter 2 if outside bend with r/w<2		1		
1234	Gravitational Constan		32.2	ft/sec^2	32.2
4	Stability Coefficient	(0.3 for angular rock and 0.36 for round	0.36		
124	Safety Factor		1.3		

1.0 to 1.2	Uniform flow, straight to mildly curving, r/w > 30, wave and debris impact minimal, no uncertainty in parameters
1.3 to 1.5	Gradually varying flow, moderate bed 10<r/w<30 wave and debris impact moderate
1.6 to 2.0	Approaching rapidly varying flow, sharp bend r/w < 10 significant impact, high turbulence, uncertainty in parameters

Output		ft	Inches	mm	# of paramters	Check
1. FHWA Energy Slope Method	D50	0.82	9.85	250.28	10	Data OK
2. FHWA Shear Method	D50	0.69	8.31	211.02	9	Data OK
3. Isbash Velocity Method	D50	0.73	8.76	222.44	7	Data OK
4. ACOE	D30	#NUM!	#NUM!	#NUM!	12	Missing data
5. Basic Shields Relation for incipient motion	D50	0.41	4.96	125.92	5	Data OK

GENERAL/CONSTRICTION SCOUR COMPUTATIONS

Based on: B.O.R. Methodology "Computing Degradation and Local Scour" 1984

Stream/River:	Silver Bow Creek	Name:	Martin Dovle
Cross-section:	U/S Reach A	Date:	4/2/98
Notes:			

df = scoured depth below designed floodwater level
di = average depth at bankfull discharge in incised reach (reach which "spills" only at high Q)
qf = designed flood discharge per unit width
qi = bankfull discharge per unit width in incised reach (reach which "spills" only at high Q)
m = exponent 0.67 for sand, 0.85 for gravel

di =	2.4	ft.	qf =	31.07
bank full top width =	30	ft.	qi =	7.67
design flow top width =	75	ft		
design discharge =	2330	cfs		
bankfull discharge =	230	cfs		
m =	0.85			

Neill Equation

Uses field measurements from "incised" reach

df = di * (qf/qi)^m

df = 7.88 ft

Lacey Equation

Includes empincal regime equation by Lacey, and method of zero bed-sediment transport by Blench.

dm = 0.47*(Q/f)^(1/3)

dm = mean depth at design discharge (ft.)
Q = design discharge (cfs)
f = silt factor f = 1.76*(Dm)^0.5
Dm = mean grain size of bed materials in mm

range:
D(50) = 1.5 inches = 38.1 mm

dm = 2.81 ft

GENERAL/CONSTRICTION SCOUR COMPUTATIONS Page 2/3

Blench Equation

Dfo = qf^(2/3)/Fbo^(1/3)

Dfo = depth for zero bed sediment transport (ft.)
qf = design flood discharge per unit width (cfs/ft)
Fbo = Blench's zero bed factor (ft/s^2)

for above D(50):
Fbo (from figure 9) = 4 ft/s^2

Dfo = 6.23 ft

Depth of Scour

ds = Zn*df
ds = Zl*dm
ds = Zb*dfo

ds = depth of scour below streambed
Zn = Neill, empirically developed multiplication factor
Zl = Lacey, empirically developed multiplication factor
Zb = Blench, empirically developed multiplication factor

General/Constriction Scour		Bend Scour*			
Multiplication factor	Straight reach	Moderate bend	Severe bend	Right angle bend	Vertical wall
Zn	0.5	0.6	0.7		
Zl	0.25	0.5	0.75	1	1.25
Zb	0.6	0.6	0.6	1.25	

Local Scour*		Spur Scour*	Weir Scour*
Multiplication factor	Nose of pier	Nose of spur dikes	Grade control or small dam
Zn	1	0.7	
Zl		1.75	1.5
Zb	1	1.75	1.25

* Use these for rough calculations only, equations specific to these scour types should be used for more accuracy

GENERAL/CONSTRICTION SCOUR COMPUTATIONS Page 3/3

PREDICTED SCOUR DEPTHS (FT)

Equation	Straight reach	Moderate bend*	Severe bend*	Right angle bend*	Vertical wall*
Neill ds =	3.9	4.7	5.5		
Lacey ds =	0.7	1.4	2.1	2.8	3.5
Blench ds =	3.7	3.7	3.7	7.8	
ds (average) =	**2.8**	**3.3**	**3.8**	**5.3**	**3.5**

Equation	Nose of pier*		Nose of sour dikes*		Grade control or small dam*
Neill ds =	7.9		5.5		
Lacey ds =			4.9		4.2
Blench ds =	6.2		10.9		7.8
ds (average) =	7.1		7.1		6.0

* Use these for rough calculations only, equations specific to these scour types should be used for more accuracy

Granular Filter Design Worksheet

Based on FHWA HEC-11

Project:	Silver Bow Creek, Reach A	Name & Date:	Martin Doyle
Notes:	Upstream Reach		4/2/98

Check to see if filter is necessary

Riprap Material:			Bank matl. (soil):		
D_{85} =	11.7	in	D_{85} =	0.04	in
D_{50} =	9	in	D_{50} =	0.031	in
D_{15} =	4.5	in	D_{15} =	0.0004	in

D_{15}(riprap)/D_{85}(soil) = 113 (this should be < 5)

D_{15}(riprap)/D_{15}(soil) = 11250 (this should be > 5 and < 40)

D_{50}(riprap)/D_{50}(soil) = 290 (this should be < 40)

Design filter to work with Riprap:

Filter #1:

D_{85} =	1.00	D_{15}(riprap)/D_{85}(filter#1) =	4.5 (this should be < 5)
D_{50} =	0.187	D_{15}(riprap)/D_{15}(filter#1) =	136.4 (should be > 5 and < 40)
D_{15} =	0.03	D_{50}(riprap)/D_{50}(filter#1) =	48.1 (this should be < 40)

Check against native material:

D_{15}(filter#1)/D_{85}(soil) = 1 (this should be < 5)

D_{15}(filter#1)/D_{15}(soil) = 83 (should be > 5 and < 40)

D_{50}(filter#1)/D_{50}(soil) = 6 (this should be < 40)

>>If these requirements are met, then Filter #1 is adequate

If Filter #1 is not adequate, then a second layer of filter material is needed.

Filter #2:

D_{85} =	0.000	D_{15}(filter#1)/D_{85}(filter#2) =	#DIV/0! (this should be < 5)
D_{50} =		D_{15}(filter#1)/D_{15}(filter#2) =	#DIV/0! (should be > 5 and < 40)
D_{15} =	0.000	D_{50}(filter#1)/D_{50}(filter#2) =	#DIV/0! (this should be < 40)

Check against native material:

D_{15}(filter#2)/D_{85}(soil) = 0 (this should be < 5)

D_{15}(filter#2)/D_{15}(soil) = 0 (should be > 5 and < 40)

D_{50}(filter#2)/D_{50}(soil) = 0 (this should be < 40)

>>If these requirements are met, then Filter #1 + Filter #2 is adequate

Final Gradations

Size in inches

	Riprap	Filter #1	Filter #2
D_{100} =	14.40	0.30	0.00
D_{85} =	11.70	1.00	0.00
D_{50} =	9.00	0.19	0.00
D_{15} =	4.50	0.03	0.00

Filter layer thickness

Single layer: 6-15 inches

Multiple layers: 4-8 inches per layer

INTER-FLUVE, INC.

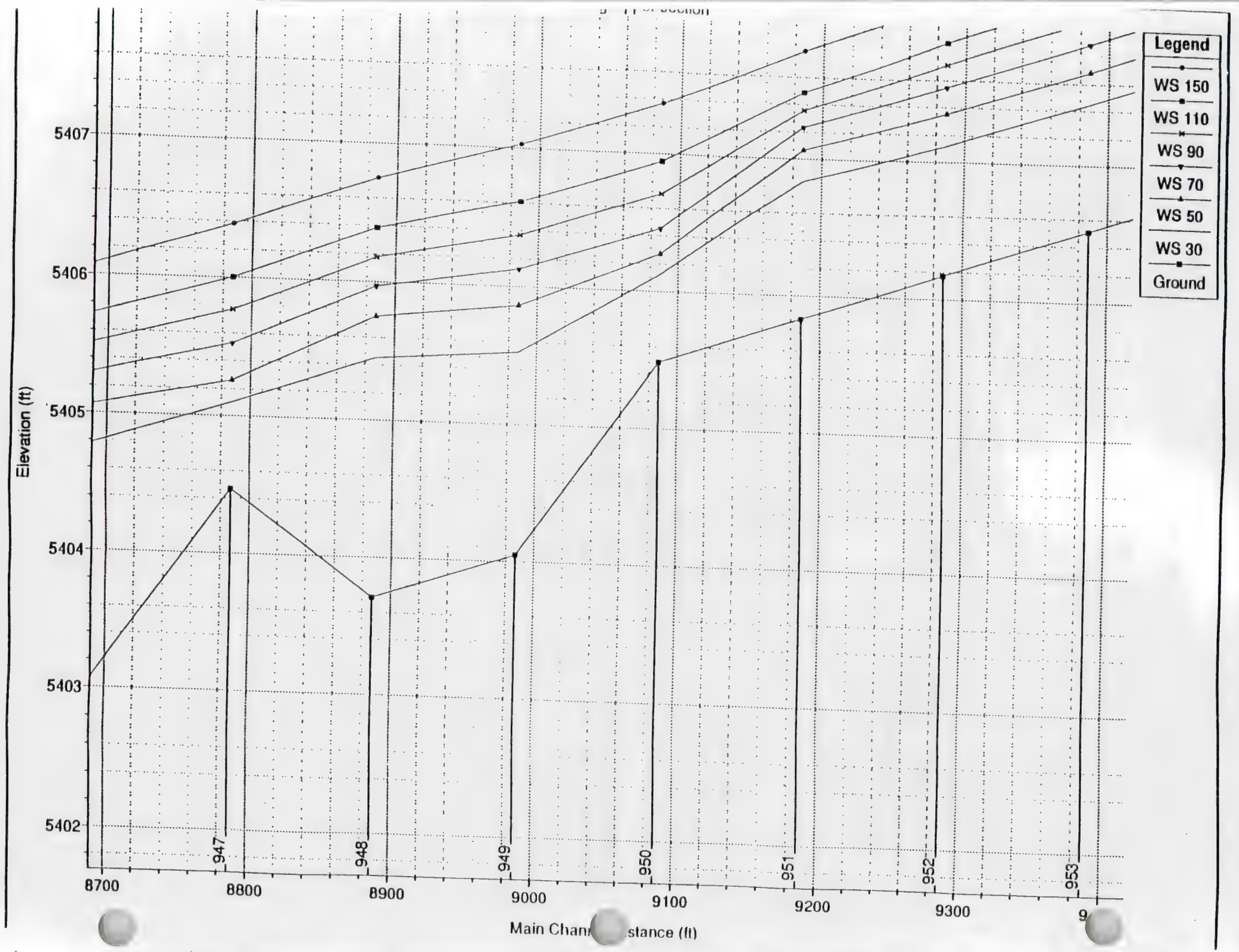
25 N. WILLSON AVE.
SUITE 5
BOZEMAN, MT 59715
(406) 586-6926
FAX (406) 586-8445

MEMORANDUM

To: ***Silver Bow Creek, SSTOU SubArea 1, Reach A***
From: ***Martin Doyle***
Date: ***4/6/98***
In Regards To: ***Critical low flow discharge for deformable channel***

The only cross sections where shears are higher for 50-cfs than for 150-cfs occurs is at riffle cross sections located immediately upstream of a pool. At these sections, the water is dropping into the pool. Hence, the higher velocities and shears are higher than at other cross sections due to the steep water surface slopes which develop (see attached figure. As the discharge increases above 50-cfs, the water surface profile is less affected by the drop (see attached figure). As shear is a function of slope, since the water slope is less steep at higher discharges, the shear decreases at higher discharges.

From further analysis of these riffle cross sections, 50-cfs was the 'critical' discharge: that is, shear decreases with both higher and lower discharges (up to about 200-cfs). See attached table for example. In table and attached figure, XS 550 is the riffle XS with associated high shears.


Legend
WS 150
WS 110
WS 90
WS 70
WS 50
WS 30
Ground
Elevation (ft)
5407
5406
5405
5404
5403
5402
947
948
949
950
951
952
953
8700
8800
8900
9000
9100
9200
9300
Main Chan stance (ft)

Silver Bow Creek, SSTOU SubArea 1, Reach A
Critical low flow discharge for shear stress

XS	Discharge cfs	Shear lb/ft2
952	30	0.13
952	50	0.17
952	70	0.21
952	90	0.25
952	110	0.28
952	150	0.33
951	30	0.11
951	50	0.15
951	70	0.2
951	90	0.25
951	110	0.3
951	150	0.35
950	30	0.55
950	50	0.71
950	70	0.67
950	90	0.51
950	110	0.44
950	150	0.39
949	30	0.08
949	50	0.14
949	70	0.19
949	90	0.23
949	110	0.27
949	150	0.31
948	30	0.05
948	50	0.1
948	70	0.15
948	90	0.2
948	110	0.24
948	150	0.3

Silver Bow Creek SSTOU, Channel Design Reach A, Q = 50 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chnl (ft/s)
975	6	50	49.13	5414.39	1.86	0.03	44.08	1.02
974	59	50	37.29	5414.35	2.08	0.06	30.24	1.35
973	129	50	30.41	5413.67	2.31	0.13	26.22	2.04
972	237	50	11.33	5412.98	1.76	0.82	19.73	4.41
971	339	50	21.6	5412.46	1.3	0.19	20.65	2.31
970.2	471	50	17.47	5411.86	1.16	0.3	21.22	2.86
970.19	639	50	24.02	5411.27	1.67	0.15	23.34	2.08
970.184	765	50	27.64	5411.01	1.82	0.11	24.23	1.81
970.183	797	50	25.42	5410.94	1.73	0.14	23.56	1.97
970.1821	836	50	26.85	5410.86	1.52	0.12	25.72	1.86
970.182	837	50	26.8	5410.86	1.52	0.12	25.71	1.87
970.181	897	50	26.12	5410.72	1.49	0.13	25.56	1.91
970.1809	898	50	26.06	5410.72	1.49	0.13	25.54	1.92
970.18	940	50	23.84	5410.6	1.4	0.16	25.16	2.1
961	1000	50	22.86	5410.4	1.17	0.18	26.89	2.19
960	1100	50	23.12	5410.07	1.18	0.17	26.91	2.16
959	1200	50	24.44	5409.78	1.23	0.15	26.99	2.05
958	1300	50	12.57	5408.99	0.78	0.69	25.13	3.98
957	1420	50	24.82	5408.65	1.88	0.12	15.41	2.01
956	1485	50	28.65	5408.55	2.12	0.09	16.57	1.75
955	1600	50	22.81	5408.36	1.17	0.18	26.89	2.19
954	1700	50	22.78	5408.02	1.17	0.18	26.89	2.19
953	1800	50	22.85	5407.68	1.17	0.18	26.89	2.19
952	1900	50	23.13	5407.35	1.18	0.17	26.91	2.16
951	1980	50	24.48	5407.06	1.23	0.15	26.99	2.04
950	2100	50	12.46	5406.27	0.78	0.71	25.08	4.01
949	2200	50	23.77	5405.86	1.81	0.14	15.07	2.1
948	2300	50	27.29	5405.75	2.04	0.1	16.17	1.83
947	2400	50	12.77	5405.26	0.79	0.67	25.22	3.92
946	2500	50	27.14	5405.06	2.03	0.1	16.12	1.84
945	2600	50	14.15	5404.64	0.85	0.53	25.82	3.53
944	2655	50	29.2	5404.51	2.16	0.09	16.74	1.71
943	2800	50	24.41	5404.34	1.23	0.15	26.99	2.05
942	2900	50	12.77	5403.56	0.79	0.67	25.22	3.92
941	2985	50	27.31	5403.37	2.04	0.1	16.18	1.83
940	3100	50	12.59	5402.87	0.78	0.69	25.14	3.97
939	3200	50	23.8	5402.47	1.82	0.14	15.08	2.1
938	3300	50	27.31	5402.35	2.04	0.1	16.18	1.83

Silver Bow Creek SSTOU, Channel Design Reach A, Q = 50 cfs (cont.)

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chnl (ft/s)
937	3400	50	12.59	5401.85	0.78	0.69	25.14	3.97
936	3500	50	27.91	5401.71	2.08	0.1	16.35	1.79
935	3600	50	32.46	5401.64	2.35	0.07	17.66	1.54
934	3700	50	31.63	5401.55	1.5	0.08	27.45	1.58
933	3800	50	39.28	5401.48	1.77	0.05	27.92	1.27
932.6			Culvert					
932	3900	50	22.24	5400.52	1.15	0.19	26.85	2.25
931	4000	50	23.1	5400.21	1.18	0.17	26.91	2.16
930	4100	50	24.41	5399.92	1.23	0.15	26.99	2.05
929	4200	50	12.77	5399.14	0.79	0.67	25.22	3.92
928	4330	50	21.23	5398.55	1.64	0.18	14.72	2.36
927	4400	50	23.8	5398.39	1.82	0.14	15.08	2.1
926	4500	50	27.31	5398.27	2.04	0.1	16.18	1.83
925	4600	50	12.57	5397.77	0.78	0.69	25.13	3.98
924	4700	50	22.01	5397.25	1.7	0.16	14.82	2.27
923	4800	50	24.9	5397.1	1.89	0.12	15.43	2.01
922	4890	50	28.74	5397	2.13	0.09	16.6	1.74
921	4970	50	23.12	5396.81	1.18	0.17	26.91	2.16
920	5040	50	24.44	5396.52	1.23	0.15	26.99	2.05
919	5200	50	12.57	5395.73	0.78	0.69	25.13	3.98
918	5300	50	25.28	5395.42	1.91	0.12	15.55	1.98
917	5400	50	29.22	5395.33	2.16	0.09	16.74	1.71
916	5500	50	24.44	5395.16	1.23	0.15	26.99	2.05
915	5600	50	12.59	5394.37	0.78	0.69	25.14	3.97
914	5665	50	27.31	5394.19	2.04	0.1	16.18	1.83
913	5800	50	12.57	5393.69	0.78	0.69	25.13	3.98
912	5930	50	23.68	5393.28	1.81	0.14	15.04	2.11
911	6005	50	27.17	5393.16	2.03	0.1	16.13	1.84
910	6100	50	13.53	5392.71	0.82	0.59	25.55	3.7
909	6185	50	28.75	5392.58	2.13	0.09	16.6	1.74
908	6300	50	23.13	5392.39	1.18	0.17	26.91	2.16
907	6400	50	24.48	5392.1	1.23	0.15	26.99	2.04
906	6500	50	12.33	5391.3	0.77	0.72	25.02	4.06
905	6600	50	27.13	5391.12	2.03	0.1	16.12	1.84
904	6700	50	14.57	5390.71	0.86	0.5	25.99	3.43
903	6790	50	29.51	5390.58	2.17	0.09	16.82	1.69
902	6900	50	25.19	5390.43	1.26	0.14	27.04	1.99

Silver Bow Creek SSTOU, Channel Design Reach A, Q = 150 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chnl (ft/s)
975	6	150	93.67	5415.35	2.82	0.07	50.15	1.65
974	59	150	69.44	5415.27	3	0.15	41.34	2.31
973	129	150	57.32	5414.6	3.24	0.32	33.56	3.43
972	237	150	28.94	5413.81	2.59	0.87	22.34	5.18
971	339	150	44.83	5413.39	2.23	0.34	27.2	3.35
970.2	471	150	38.81	5412.79	2.09	0.45	24.65	3.86
970.19	639	150	50.23	5412.26	2.66	0.27	29.57	2.99
970.184	765	150	53.26	5411.95	2.76	0.23	30.33	2.82
970.183	797	150	49.58	5411.84	2.63	0.28	29.44	3.03
970.1821	836	150	52.28	5411.75	2.41	0.25	33.05	2.95
970.182	837	150	52.19	5411.74	2.4	0.25	33.01	2.96
970.181	897	150	50.68	5411.58	2.35	0.27	36.19	3.05
970.1809	898	150	50.58	5411.58	2.35	0.27	36.06	3.06
970.18	940	150	46.63	5411.43	2.23	0.32	30.95	3.28
961	1000	150	45.34	5411.22	1.99	0.33	28.29	3.31
960	1100	150	45.09	5410.87	1.98	0.33	28.28	3.33
959	1200	150	44.5	5410.51	1.96	0.34	28.24	3.37
958	1300	150	42.67	5410.1	1.89	0.38	28.13	3.52
957	1420	150	46.33	5409.78	3.01	0.31	25.31	3.24
956	1485	150	48.03	5409.5	3.07	0.28	26.2	3.12
955	1600	150	45.44	5409.18	1.99	0.33	28.3	3.3
954	1700	150	45.4	5408.84	1.99	0.33	28.29	3.3
953	1800	150	45.32	5408.5	1.99	0.33	28.29	3.31
952	1900	150	45.07	5408.15	1.98	0.33	28.27	3.33
951	1980	150	44.38	5407.78	1.95	0.35	28.23	3.38
950	2100	150	42.27	5407.37	1.88	0.39	28.1	3.55
949	2200	150	45.73	5407.03	2.98	0.31	24.98	3.28
948	2300	150	47.13	5406.75	3.04	0.3	25.73	3.18
947	2400	150	43.23	5406.38	1.91	0.37	28.16	3.47
946	2500	150	47.26	5406.07	3.04	0.29	25.8	3.17
945	2600	150	43.56	5405.71	1.92	0.36	28.18	3.44
944	2655	150	47.74	5405.41	3.06	0.29	26.05	3.14
943	2800	150	44.75	5405.08	1.97	0.34	28.26	3.35
942	2900	150	43.48	5404.69	1.92	0.36	28.18	3.45
941	2985	150	47.61	5404.39	3.06	0.29	25.98	3.15
940	3100	150	44.43	5404.05	1.96	0.34	28.24	3.38
939	3200	150	49.06	5403.76	3.11	0.27	26.73	3.06
938	3300	150	52.03	5403.53	3.22	0.24	28.2	2.88

Silver Bow Creek SSTOU, Channel Design Reach A, Q = 150 cfs (cont.)

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chnl (ft/s)
937	3400	150	52.53	5403.31	2.24	0.23	28.72	2.86
936	3500	150	61.11	5403.15	3.52	0.17	35.93	2.46
935	3600	150	74.38	5403.04	3.75	0.13	81.65	2.18
934	3700	150	97.77	5402.96	2.91	0.1	130.5	1.99
933	3800	150	105.15	5402.92	3.21	0.08	191.83	1.73
932.6			Culvert					
932	3900	150	44.39	5401.32	1.95	0.34	28.23	3.38
931	4000	150	45.01	5401.01	1.98	0.33	28.27	3.33
930	4100	150	44.2	5400.64	1.95	0.35	28.22	3.39
929	4200	150	41.56	5400.2	1.85	0.4	28.06	3.61
928	4330	150	44.59	5399.85	2.94	0.33	24.35	3.36
927	4400	150	45.43	5399.54	2.97	0.32	24.81	3.3
926	4500	150	46.67	5399.25	3.02	0.3	25.48	3.21
925	4600	150	41.9	5398.86	1.87	0.39	28.08	3.58
924	4700	150	45.14	5398.51	2.96	0.32	24.66	3.32
923	4800	150	46.22	5398.21	3	0.31	25.25	3.25
922	4890	150	47.88	5397.94	3.07	0.29	26.12	3.13
921	4970	150	45.09	5397.61	1.98	0.33	28.28	3.33
920	5040	150	44.45	5397.25	1.96	0.34	28.24	3.37
919	5200	150	42.51	5396.84	1.89	0.38	28.12	3.53
918	5300	150	46.1	5396.51	3	0.31	25.18	3.25
917	5400	150	47.69	5396.23	3.06	0.29	26.02	3.15
916	5500	150	44.58	5395.89	1.96	0.34	28.25	3.36
915	5600	150	42.97	5395.49	1.9	0.37	28.15	3.49
914	5655	150	46.82	5395.18	3.03	0.3	25.56	3.2
913	5800	150	42.34	5394.79	1.88	0.38	28.11	3.54
912	5930	150	45.85	5394.46	2.99	0.31	25.04	3.27
911	6005	150	47.32	5394.18	3.05	0.29	25.83	3.17
910	6100	150	43.7	5393.82	1.93	0.36	28.19	3.43
909	6185	150	47.95	5393.52	3.07	0.29	26.15	3.13
908	6300	150	45.23	5393.19	1.98	0.33	28.28	3.32
907	6400	150	44.89	5392.84	1.97	0.34	28.26	3.34
906	6500	150	43.82	5392.46	1.93	0.36	28.2	3.42
905	6600	150	48.13	5392.17	3.08	0.28	26.25	3.12
904	6700	150	45.62	5391.85	2	0.32	28.31	3.29
903	6790	150	50.86	5391.59	3.18	0.25	27.63	2.95
902	6900	150	50.72	5391.35	2.18	0.25	28.62	2.96

Silver Bow Creek SSTOU, Channel Design Reach A, Q = 200 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chnl (ft/s)
975	6	200	112.43	5415.71	3.18	0.09	53.44	1.86
974	59	200	84.7	5415.61	3.34	0.18	45.43	2.61
973	129	200	69.42	5414.95	3.59	0.39	35.81	3.87
972	237	200	36.69	5414.15	2.93	0.9	23.38	5.45
971	339	200	55.22	5413.75	2.59	0.38	31.16	3.62
970.2	471	200	46.83	5413.11	2.41	0.52	25.75	4.27
970.19	639	200	60.41	5412.58	2.98	0.31	32.94	3.33
970.184	765	200	63.79	5412.27	3.08	0.28	34.16	3.17
970.183	797	200	59.57	5412.17	2.96	0.32	32.63	3.37
970.1821	836	200	63.76	5412.07	2.73	0.3	37.77	3.32
970.182	837	200	63.65	5412.07	2.73	0.31	37.22	3.33
970.181	897	200	63.37	5411.91	2.68	0.32	40.36	3.4
970.1809	898	200	63.26	5411.9	2.67	0.32	40.52	3.4
970.18	940	200	58.46	5411.75	2.55	0.37	39.62	3.63
961	1000	200	54.56	5411.54	2.31	0.38	28.85	3.67
960	1100	200	54.48	5411.2	2.31	0.38	28.84	3.67
959	1200	200	54.29	5410.85	2.3	0.39	28.83	3.68
958	1300	200	53.87	5410.5	2.29	0.39	28.81	3.71
957	1420	200	57.46	5410.17	3.4	0.35	30.71	3.48
956	1485	200	58.16	5409.86	3.43	0.34	31.01	3.44
955	1600	200	54.62	5409.5	2.31	0.38	28.85	3.66
954	1700	200	54.59	5409.16	2.31	0.38	28.85	3.66
953	1800	200	54.56	5408.82	2.31	0.38	28.85	3.67
952	1900	200	54.47	5408.48	2.31	0.38	28.84	3.67
951	1980	200	54.25	5408.13	2.3	0.39	28.83	3.69
950	2100	200	53.76	5407.77	2.28	0.4	28.8	3.72
949	2200	200	57.31	5407.45	3.4	0.35	30.64	3.49
948	2300	200	57.92	5407.13	3.42	0.34	30.91	3.45
947	2400	200	54.14	5406.77	2.3	0.39	28.82	3.69
946	2500	200	57.97	5406.45	3.42	0.34	30.93	3.45
945	2600	200	54.25	5406.09	2.3	0.39	28.83	3.69
944	2655	200	58.17	5405.78	3.43	0.34	31.02	3.44
943	2800	200	54.63	5405.42	2.31	0.38	28.85	3.66
942	2900	200	54.63	5405.08	2.31	0.38	28.85	3.66
941	2985	200	58.87	5404.78	3.45	0.33	31.32	3.4
940	3100	200	55.87	5404.45	2.36	0.36	28.92	3.58
939	3200	200	61.19	5404.17	3.52	0.31	36.65	3.27
938	3300	200	65.52	5403.93	3.62	0.27	55.66	3.11

Silver Bow Creek SSTOU, Channel Design Reach A, Q = 200 cfs (cont.)

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chnl (ft/s)
937	3400	200	70.14	5403.71	2.64	0.26	78.25	3.09
936	3500	200	96.09	5403.59	3.96	0.18	123.98	2.57
935	3600	200	135.6	5403.51	4.22	0.12	177.4	2.17
934	3700	200	184.78	5403.46	3.41	0.09	205.05	1.89
933	3800	200	146.59	5403.42	3.71	0.08	289.92	1.87
932.6			Culvert					
932	3900	200	53.61	5401.65	2.28	0.4	28.79	3.73
931	4000	200	54.43	5401.34	2.31	0.38	28.84	3.67
930	4100	200	54.16	5400.99	2.3	0.39	28.82	3.69
929	4200	200	53.54	5400.63	2.28	0.4	28.79	3.74
928	4330	200	56.83	5400.29	3.38	0.36	30.42	3.52
927	4400	200	57.13	5399.96	3.39	0.35	30.56	3.5
926	4500	200	57.64	5399.64	3.41	0.35	30.79	3.47
925	4600	200	53.61	5399.27	2.28	0.4	28.79	3.73
924	4700	200	57	5398.94	3.39	0.36	30.5	3.51
923	4800	200	57.42	5398.61	3.4	0.35	30.69	3.48
922	4890	200	58.08	5398.29	3.42	0.34	30.98	3.44
921	4970	200	54.48	5397.94	2.31	0.38	28.84	3.67
920	5040	200	54.27	5397.59	2.3	0.39	28.83	3.69
919	5200	200	53.82	5397.23	2.28	0.39	28.8	3.72
918	5300	200	57.39	5396.91	3.4	0.35	30.67	3.49
917	5400	200	58.04	5396.59	3.42	0.34	30.96	3.45
916	5500	200	54.35	5396.23	2.3	0.39	28.83	3.68
915	5600	200	54.02	5395.88	2.29	0.39	28.81	3.7
914	5655	200	57.75	5395.56	3.41	0.35	30.83	3.46
913	5800	200	53.8	5395.19	2.28	0.4	28.8	3.72
912	5930	200	57.33	5394.87	3.4	0.35	30.65	3.49
911	6005	200	57.97	5394.55	3.42	0.34	30.93	3.45
910	6100	200	54.25	5394.19	2.3	0.39	28.83	3.69
909	6185	200	58.18	5393.88	3.43	0.34	31.02	3.44
908	6300	200	54.65	5393.52	2.31	0.38	28.85	3.66
907	6400	200	54.65	5393.18	2.31	0.38	28.85	3.66
906	6500	200	54.67	5392.84	2.31	0.38	28.85	3.66
905	6600	200	58.93	5392.54	3.45	0.33	31.35	3.39
904	6700	200	55.99	5392.21	2.36	0.36	28.93	3.57
903	6790	200	61.48	5391.94	3.53	0.3	37.97	3.26
902	6900	200	61.01	5391.67	2.5	0.31	48.97	3.33

INTER-FLUVE, INC.

25 N. WILLSON AVE.
SUITE 5
BOZEMAN, MT 59715
(406) 586-6926
FAX (406) 586-8445

MEMORANDUM

To: ***Silver Bow Creek SSTOU, SubArea 1, Reach A***
From: ***Martin Doyle***
Date: ***4/7/98***
In Regards To: ***Determination of bank treatment types: inside vs. outside For deformable channel***

Due to the formation of secondary flow currents within a stream meander bend, all erosional forces are concentrated at the outside of bends. Secondary currents also cause the inside of meander bends to be a depositional area. Following these well established fluvial geomorphic facts, we determined that the outside of meander bends should be the focal point of bank protection, hence the depth of scour and incipient motion analysis as well as the concentrated vegetative treatments. Similarly, because of the relatively non-existant erosive forces on the inside of meander bends, we attempted to imitate what is commonly found in natural streams: a point bar.

Mussetter Engineering Inc.

Transmittal

To:	Peter Skidmore Inter-Fluve, Inc. 25 North Wilson, Suite 5 Bozeman, Montana 59715	**From:**	Gary Wolff
Date:	February 18, 1998	**Project:**	96-08
Subject:	Appendix material		

☒ For Your Use	☐ Revise and Resubmit	☐ Returned
☐ For Approval	☐ Review Completed	☐ For Signature and Return
☐ For Review and Comment	☐ _____	

Remarks:

Peter,

Enclosed is a copy of the summary output from the HEC-RAS model and tables summarizing reach-averaged hydraulics and computed sediment transport capacities for the various design alternatives. Please feel free to give us a call if you have any questions.

- Gary

1730 S. College Avenue, Suite 100, Fort Collins, CO (80525), P.O. Box 270785, Fort Collins, Colorado 80527
970-224-4612, fax: 970-472-6062

Design Channel: Bankfull Discharge = 150 cfs; slope = 0.0016 ft/ft

Profile Output Table - Standard Table 1
HEC-RAS Plan: qb150sp16 River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 626
Plans = 1
Profiles = 15

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	20	10.00	99.18	99.73	99.63	99.78	0.008950	1.74	5.74	20.05	0.57
Reach-1	20	20.00	99.18	99.96	99.76	100.01	0.005644	1.85	10.83	24.51	0.49
Reach-1	20	30.00	99.18	100.15	99.86	100.20	0.004194	1.92	15.60	26.53	0.44
Reach-1	20	40.00	99.18	100.31	99.95	100.37	0.003352	1.98	20.19	27.66	0.41
Reach-1	20	50.00	99.18	100.47	100.02	100.53	0.002821	2.04	24.46	27.94	0.39
Reach-1	20	60.00	99.18	100.61	100.09	100.68	0.002521	2.11	28.38	28.20	0.37
Reach-1	20	70.00	99.18	100.74	100.15	100.81	0.002322	2.18	32.06	28.43	0.36
Reach-1	20	80.00	99.18	100.86	100.21	100.94	0.002185	2.25	35.54	28.65	0.36
Reach-1	20	90.00	99.18	100.97	100.27	101.06	0.002093	2.32	38.80	28.86	0.35
Reach-1	20	100.00	99.18	101.08	100.32	101.17	0.002023	2.39	41.93	29.06	0.35
Reach-1	20	200.00	99.18	101.89	100.76	102.03	0.001840	2.99	74.86	89.61	0.35
Reach-1	20	500.00	99.18	102.93	102.00	103.08	0.001711	3.72	275.35	298.90	0.36
Reach-1	20	750.00	99.18	103.39	102.68	103.54	0.001665	4.01	435.62	392.86	0.37
Reach-1	20	1000.00	99.18	103.70	103.01	103.85	0.001646	4.21	559.26	400.00	0.37
Reach-1	20	1500.00	99.18	104.20	103.51	104.35	0.001644	4.55	759.06	400.00	0.38
Reach-1	19.8*	10.00	98.95	99.59	99.42	99.63	0.005907	1.66	6.02	16.53	0.48
Reach-1	19.8*	20.00	98.95	99.86	99.58	99.91	0.004417	1.79	11.19	22.08	0.44
Reach-1	19.8*	30.00	98.95	100.07	99.70	100.13	0.003399	1.86	16.11	24.49	0.40
Reach-1	19.8*	40.00	98.95	100.25	99.81	100.31	0.002914	1.93	20.73	26.55	0.38
Reach-1	19.8*	50.00	98.95	100.42	99.89	100.48	0.002606	1.99	25.18	28.37	0.37
Reach-1	19.8*	60.00	98.95	100.56	99.97	100.63	0.002297	2.04	29.35	28.67	0.36
Reach-1	19.8*	70.00	98.95	100.70	100.04	100.77	0.002103	2.11	33.22	28.92	0.35
Reach-1	19.8*	80.00	98.95	100.82	100.10	100.89	0.001975	2.17	36.85	29.14	0.34
Reach-1	19.8*	90.00	98.95	100.94	100.17	101.01	0.001893	2.24	40.22	29.35	0.34
Reach-1	19.8*	100.00	98.95	101.05	100.22	101.13	0.001831	2.30	43.45	29.55	0.33
Reach-1	19.8*	200.00	98.95	101.86	100.68	101.99	0.001692	2.90	76.95	90.17	0.34
Reach-1	19.8*	500.00	98.95	102.89	101.78	103.05	0.001633	3.66	277.25	298.81	0.36
Reach-1	19.8*	750.00	98.95	103.36	102.62	103.51	0.001611	3.98	436.99	392.44	0.36
Reach-1	19.8*	1000.00	98.95	103.66	102.95	103.81	0.001607	4.19	560.06	400.16	0.37
Reach-1	19.8*	1500.00	98.95	104.16	103.47	104.32	0.001616	4.54	759.85	400.16	0.38
Reach-1	19.6*	10.00	98.72	99.55	99.18	99.57	0.001833	1.18	8.46	15.99	0.29
Reach-1	19.6*	20.00	98.72	99.81	99.35	99.85	0.002120	1.53	13.09	18.70	0.32
Reach-1	19.6*	30.00	98.72	100.02	99.48	100.07	0.002362	1.73	17.38	22.40	0.35
Reach-1	19.6*	40.00	98.72	100.21	99.60	100.26	0.002274	1.84	21.72	24.62	0.35
Reach-1	19.6*	50.00	98.72	100.37	99.70	100.43	0.002181	1.93	25.93	26.55	0.34
Reach-1	19.6*	60.00	98.72	100.52	99.79	100.58	0.002099	2.00	30.03	28.30	0.34
Reach-1	19.6*	70.00	98.72	100.66	99.88	100.72	0.001984	2.06	34.02	29.34	0.34

Reach-1	19.6*	80.00	98.72	100.79	99.96	100.85	0.001855	2.12	37.78	29.59	0.33
Reach-1	19.6*	90.00	98.72	100.90	100.04	100.98	0.001775	2.18	41.27	29.81	0.33
Reach-1	19.6*	100.00	98.72	101.01	100.10	101.09	0.001717	2.24	44.58	30.02	0.32
Reach-1	19.6*	200.00	98.72	101.84	100.63	101.96	0.001589	2.83	79.35	93.02	0.33
Reach-1	19.6*	500.00	98.72	102.87	101.63	103.01	0.001551	3.59	282.61	301.57	0.35
Reach-1	19.6*	750.00	98.72	103.33	102.55	103.48	0.001543	3.91	443.27	394.94	0.36
Reach-1	19.6*	1000.00	98.72	103.64	102.89	103.78	0.001547	4.12	566.18	400.34	0.36
Reach-1	19.6*	1500.00	98.72	104.13	103.42	104.28	0.001569	4.49	765.63	400.34	0.37
Reach-1	19.4*	10.00	98.49	99.53	98.93	99.54	0.000686	0.88	11.35	15.79	0.18
Reach-1	19.4*	20.00	98.49	99.79	99.11	99.81	0.001096	1.28	15.68	17.74	0.24
Reach-1	19.4*	30.00	98.49	99.99	99.25	100.03	0.001359	1.54	19.45	19.36	0.27
Reach-1	19.4*	40.00	98.49	100.17	99.38	100.22	0.001630	1.73	23.19	22.35	0.30
Reach-1	19.4*	50.00	98.49	100.33	99.48	100.39	0.001734	1.85	27.01	24.52	0.31
Reach-1	19.4*	60.00	98.49	100.48	99.58	100.54	0.001777	1.95	30.79	26.35	0.32
Reach-1	19.4*	70.00	98.49	100.62	99.67	100.69	0.001794	2.03	34.54	28.04	0.32
Reach-1	19.4*	80.00	98.49	100.75	99.75	100.82	0.001795	2.09	38.25	29.62	0.32
Reach-1	19.4*	90.00	98.49	100.87	99.83	100.94	0.001736	2.15	41.82	30.18	0.32
Reach-1	19.4*	100.00	98.49	100.98	99.90	101.06	0.001675	2.21	45.21	30.41	0.32
Reach-1	19.4*	200.00	98.49	101.81	100.53	101.93	0.001543	2.78	80.57	93.76	0.33
Reach-1	19.4*	500.00	98.49	102.84	101.55	102.98	0.001518	3.54	284.39	302.04	0.34
Reach-1	19.4*	750.00	98.49	103.30	102.51	103.44	0.001518	3.87	444.91	395.17	0.35
Reach-1	19.4*	1000.00	98.49	103.61	102.85	103.75	0.001527	4.09	567.63	400.50	0.36
Reach-1	19.4*	1500.00	98.49	104.10	103.39	104.25	0.001555	4.46	766.92	400.50	0.37
Reach-1	19.2*	10.00	98.26	99.52	98.69	99.53	0.000333	0.71	14.11	15.60	0.13
Reach-1	19.2*	20.00	98.26	99.78	98.87	99.80	0.000645	1.10	18.24	17.14	0.19
Reach-1	19.2*	30.00	98.26	99.98	99.02	100.01	0.000887	1.38	21.78	18.39	0.22
Reach-1	19.2*	40.00	98.26	100.15	99.15	100.19	0.001088	1.59	25.08	19.76	0.25
Reach-1	19.2*	50.00	98.26	100.31	99.26	100.36	0.001312	1.76	28.39	22.22	0.27
Reach-1	19.2*	60.00	98.26	100.45	99.37	100.51	0.001459	1.89	31.78	24.26	0.29
Reach-1	19.2*	70.00	98.26	100.59	99.47	100.65	0.001548	1.99	35.19	25.98	0.30
Reach-1	19.2*	80.00	98.26	100.72	99.55	100.78	0.001609	2.07	38.60	27.59	0.31
Reach-1	19.2*	90.00	98.26	100.84	99.64	100.91	0.001656	2.15	41.95	29.08	0.31
Reach-1	19.2*	100.00	98.26	100.95	99.72	101.02	0.001688	2.21	45.30	30.53	0.32
Reach-1	19.2*	200.00	98.26	101.78	100.41	101.89	0.001546	2.76	81.17	94.46	0.33
Reach-1	19.2*	500.00	98.26	102.81	101.52	102.95	0.001505	3.50	286.25	303.34	0.34
Reach-1	19.2*	750.00	98.26	103.27	102.47	103.41	0.001505	3.83	447.30	396.57	0.35
Reach-1	19.2*	1000.00	98.26	103.58	102.81	103.72	0.001513	4.04	570.04	400.66	0.35
Reach-1	19.2*	1500.00	98.26	104.07	103.35	104.22	0.001543	4.41	769.13	400.66	0.37
Reach-1	19.*	10.00	98.03	99.52	98.45	99.53	0.000189	0.60	16.77	15.44	0.10
Reach-1	19.*	20.00	98.03	99.77	98.64	99.78	0.000415	0.96	20.77	16.73	0.15
Reach-1	19.*	30.00	98.03	99.97	98.79	99.99	0.000617	1.24	24.15	17.79	0.19
Reach-1	19.*	40.00	98.03	100.14	98.93	100.17	0.000785	1.47	27.26	18.71	0.21
Reach-1	19.*	50.00	98.03	100.29	99.05	100.33	0.000942	1.66	30.21	19.81	0.24
Reach-1	19.*	60.00	98.03	100.43	99.16	100.48	0.001129	1.81	33.15	21.82	0.26
Reach-1	19.*	70.00	98.03	100.56	99.26	100.62	0.001281	1.94	36.16	23.70	0.28
Reach-1	19.*	80.00	98.03	100.69	99.35	100.75	0.001394	2.04	39.22	25.35	0.29
Reach-1	19.*	90.00	98.03	100.80	99.44	100.87	0.001487	2.13	42.25	26.88	0.30
Reach-1	19.*	100.00	98.03	100.91	99.52	100.99	0.001560	2.21	45.30	28.34	0.31
Reach-1	19.*	200.00	98.03	101.75	100.21	101.86	0.001587	2.75	81.76	96.57	0.33
Reach-1	19.*	500.00	98.03	102.78	101.53	102.92	0.001497	3.46	289.84	305.51	0.34
Reach-1	19.*	750.00	98.03	103.24	102.43	103.38	0.001487	3.76	451.98	397.16	0.34
Reach-1	19.*	1000.00	98.03	103.55	102.74	103.69	0.001495	3.98	574.63	400.84	0.35
Reach-1	19.*	1500.00	98.03	104.05	103.30	104.19	0.001529	4.35	773.43	400.84	0.36
Reach-1	18.8	10.00	97.80	99.52	98.21	99.52	0.000122	0.52	19.20	15.22	0.08
Reach-1	18.8	20.00	97.80	99.77	98.41	99.78	0.000292	0.87	23.08	16.34	0.13

Reach-1	18.8	30.00	97.80	99.96	98.57	99.98	0.000458	1.14	26.32	17.28	0.16
Reach-1	18.8	40.00	97.80	100.13	98.71	100.15	0.000609	1.37	29.29	18.10	0.19
Reach-1	18.8	50.00	97.80	100.28	98.83	100.31	0.000742	1.56	32.08	18.83	0.21
Reach-1	18.8	60.00	97.80	100.41	98.94	100.46	0.000869	1.73	34.73	19.63	0.23
Reach-1	18.8	70.00	97.80	100.54	99.05	100.60	0.001033	1.87	37.36	21.37	0.25
Reach-1	18.8	80.00	97.80	100.66	99.15	100.73	0.001177	2.00	40.05	23.02	0.27
Reach-1	18.8	90.00	97.80	100.78	99.24	100.85	0.001304	2.11	42.74	24.56	0.28
Reach-1	18.8	100.00	97.80	100.89	99.33	100.96	0.001411	2.20	45.47	26.02	0.29
Reach-1	18.8	200.00	97.80	101.71	100.06	101.83	0.001693	2.78	80.81	96.13	0.33
Reach-1	18.8	500.00	97.80	102.75	101.59	102.89	0.001529	3.44	290.51	306.68	0.34
Reach-1	18.8	750.00	97.80	103.21	102.40	103.35	0.001504	3.73	453.61	398.50	0.34
Reach-1	18.8	1000.00	97.80	103.52	102.73	103.65	0.001504	3.93	576.49	401.00	0.35
Reach-1	18.8	1500.00	97.80	104.02	103.17	104.15	0.001535	4.30	775.16	401.00	0.36
Reach-1	18.6*	10.00	98.07	99.51	98.49	99.52	0.000204	0.61	16.52	15.88	0.10
Reach-1	18.6*	20.00	98.07	99.75	98.68	99.77	0.000447	0.98	20.50	17.25	0.16
Reach-1	18.6*	30.00	98.07	99.94	98.83	99.97	0.000664	1.26	23.84	18.35	0.19
Reach-1	18.6*	40.00	98.07	100.11	98.96	100.14	0.000845	1.49	26.92	19.31	0.22
Reach-1	18.6*	50.00	98.07	100.25	99.08	100.30	0.001066	1.67	29.92	21.47	0.25
Reach-1	18.6*	60.00	98.07	100.39	99.18	100.44	0.001250	1.82	32.97	23.48	0.27
Reach-1	18.6*	70.00	98.07	100.52	99.28	100.57	0.001381	1.94	36.05	25.12	0.29
Reach-1	18.6*	80.00	98.07	100.64	99.37	100.70	0.001482	2.04	39.15	26.66	0.30
Reach-1	18.6*	90.00	98.07	100.75	99.46	100.82	0.001564	2.13	42.22	28.11	0.31
Reach-1	18.6*	100.00	98.07	100.85	99.54	100.93	0.001626	2.21	45.31	29.50	0.31
Reach-1	18.6*	200.00	98.07	101.68	100.25	101.80	0.001573	2.76	81.23	95.13	0.33
Reach-1	18.6*	500.00	98.07	102.72	101.44	102.86	0.001497	3.48	288.61	305.02	0.34
Reach-1	18.6*	750.00	98.07	103.18	102.37	103.32	0.001491	3.79	450.56	397.50	0.35
Reach-1	18.6*	1000.00	98.07	103.48	102.71	103.62	0.001501	4.01	572.89	400.75	0.35
Reach-1	18.6*	1500.00	98.07	103.98	103.24	104.12	0.001533	4.38	771.88	400.75	0.36
Reach-1	18.4*	10.00	98.33	99.51	98.77	99.51	0.000415	0.74	13.55	16.82	0.14
Reach-1	18.4*	20.00	98.33	99.74	98.95	99.76	0.000788	1.13	17.64	18.54	0.20
Reach-1	18.4*	30.00	98.33	99.92	99.09	99.95	0.001129	1.42	21.15	20.78	0.25
Reach-1	18.4*	40.00	98.33	100.08	99.22	100.12	0.001402	1.62	24.67	23.32	0.28
Reach-1	18.4*	50.00	98.33	100.22	99.32	100.27	0.001555	1.77	28.17	25.09	0.30
Reach-1	18.4*	60.00	98.33	100.36	99.42	100.41	0.001657	1.90	31.64	26.74	0.31
Reach-1	18.4*	70.00	98.33	100.48	99.51	100.54	0.001721	1.99	35.09	28.28	0.32
Reach-1	18.4*	80.00	98.33	100.60	99.59	100.67	0.001757	2.07	38.57	29.75	0.32
Reach-1	18.4*	90.00	98.33	100.71	99.67	100.78	0.001717	2.14	41.96	30.19	0.32
Reach-1	18.4*	100.00	98.33	100.82	99.75	100.90	0.001673	2.21	45.22	30.41	0.32
Reach-1	18.4*	200.00	98.33	101.65	100.37	101.77	0.001545	2.78	80.54	93.82	0.33
Reach-1	18.4*	500.00	98.33	102.68	101.39	102.82	0.001509	3.53	285.62	303.27	0.34
Reach-1	18.4*	750.00	98.33	103.14	102.35	103.29	0.001509	3.86	446.63	396.53	0.35
Reach-1	18.4*	1000.00	98.33	103.44	102.69	103.59	0.001523	4.08	568.40	400.50	0.36
Reach-1	18.4*	1500.00	98.33	103.94	103.23	104.09	0.001547	4.45	768.44	400.50	0.37
Reach-1	18.2*	10.00	98.60	99.48	99.06	99.50	0.001274	1.01	9.93	18.21	0.24
Reach-1	18.2*	20.00	98.60	99.70	99.23	99.73	0.001979	1.40	14.32	22.33	0.31
Reach-1	18.2*	30.00	98.60	99.88	99.36	99.92	0.002181	1.63	18.38	24.32	0.33
Reach-1	18.2*	40.00	98.60	100.03	99.46	100.08	0.002237	1.79	22.32	26.11	0.34
Reach-1	18.2*	50.00	98.60	100.18	99.56	100.23	0.002227	1.91	26.20	27.76	0.35
Reach-1	18.2*	60.00	98.60	100.31	99.66	100.37	0.002153	2.00	30.03	28.91	0.35
Reach-1	18.2*	70.00	98.60	100.44	99.73	100.50	0.002023	2.08	33.72	29.14	0.34
Reach-1	18.2*	80.00	98.60	100.56	99.80	100.63	0.001924	2.15	37.25	29.36	0.34
Reach-1	18.2*	90.00	98.60	100.67	99.87	100.75	0.001852	2.22	40.60	29.57	0.33
Reach-1	18.2*	100.00	98.60	100.78	99.93	100.86	0.001795	2.28	43.83	29.77	0.33
Reach-1	18.2*	200.00	98.60	101.61	100.41	101.73	0.001640	2.86	77.98	91.08	0.34
Reach-1	18.2*	500.00	98.60	102.64	101.46	102.79	0.001590	3.63	279.81	300.06	0.35
Reach-1	18.2*	750.00	98.60	103.10	102.34	103.25	0.001576	3.94	439.88	393.53	0.36

Reach-1	18.2*	1000.00	98.60	103.41	102.69	103.56	0.001579	4.16	562.61	400.25	0.36
Reach-1	18.2*	1500.00	98.60	103.91	103.20	104.06	0.001590	4.51	762.92	400.25	0.37
Reach-1	18	10.00	98.86	99.37	99.31	99.44	0.013767	2.02	4.95	19.17	0.70
Reach-1	18	20.00	98.86	99.59	99.44	99.66	0.007883	2.06	9.71	24.02	0.57
Reach-1	18	30.00	98.86	99.78	99.54	99.85	0.005203	2.07	14.52	26.09	0.49
Reach-1	18	40.00	98.86	99.95	99.63	100.02	0.004032	2.10	19.08	27.59	0.44
Reach-1	18	50.00	98.86	100.11	99.70	100.18	0.003287	2.14	23.33	27.87	0.41
Reach-1	18	60.00	98.86	100.25	99.77	100.32	0.002868	2.20	27.26	28.12	0.39
Reach-1	18	70.00	98.86	100.38	99.83	100.46	0.002590	2.26	30.99	28.36	0.38
Reach-1	18	80.00	98.86	100.50	99.89	100.59	0.002398	2.32	34.52	28.59	0.37
Reach-1	18	90.00	98.86	100.62	99.95	100.71	0.002265	2.38	37.85	28.80	0.37
Reach-1	18	100.00	98.86	100.73	100.00	100.82	0.002164	2.44	41.04	29.00	0.36
Reach-1	18	200.00	98.86	101.56	100.44	101.70	0.001890	3.01	73.48	86.42	0.36
Reach-1	18	500.00	98.86	102.59	101.68	102.76	0.001747	3.75	271.98	296.60	0.37
Reach-1	18	750.00	98.86	103.06	102.36	103.22	0.001689	4.04	432.41	391.19	0.37
Reach-1	18	1000.00	98.86	103.37	102.69	103.52	0.001663	4.23	556.90	400.00	0.37
Reach-1	18	1500.00	98.86	103.88	103.19	104.03	0.001652	4.56	757.71	400.00	0.38
Reach-1	17.8*	10.00	98.63	99.24	99.07	99.27	0.005045	1.54	6.51	17.85	0.45
Reach-1	17.8*	20.00	98.63	99.50	99.21	99.55	0.003610	1.71	11.72	21.31	0.41
Reach-1	17.8*	30.00	98.63	99.72	99.32	99.77	0.003125	1.81	16.62	24.92	0.39
Reach-1	17.8*	40.00	98.63	99.90	99.42	99.95	0.002643	1.87	21.36	26.69	0.37
Reach-1	17.8*	50.00	98.63	100.06	99.51	100.12	0.002327	1.94	25.78	27.72	0.35
Reach-1	17.8*	60.00	98.63	100.21	99.59	100.27	0.002099	2.01	29.86	28.06	0.34
Reach-1	17.8*	70.00	98.63	100.34	99.66	100.41	0.001949	2.08	33.69	28.38	0.34
Reach-1	17.8*	80.00	98.63	100.47	99.73	100.54	0.001847	2.14	37.31	28.67	0.33
Reach-1	17.8*	90.00	98.63	100.59	99.79	100.66	0.001778	2.21	40.70	28.95	0.33
Reach-1	17.8*	100.00	98.63	100.70	99.85	100.78	0.001727	2.27	43.96	29.21	0.33
Reach-1	17.8*	200.00	98.63	101.53	100.31	101.66	0.001619	2.87	77.14	87.83	0.34
Reach-1	17.8*	500.00	98.63	102.56	101.31	102.72	0.001610	3.67	275.39	296.72	0.36
Reach-1	17.8*	750.00	98.63	103.03	102.28	103.18	0.001595	3.99	434.93	390.75	0.36
Reach-1	17.8*	1000.00	98.63	103.34	102.62	103.49	0.001597	4.21	558.36	400.16	0.37
Reach-1	17.8*	1500.00	98.63	103.84	103.15	103.99	0.001605	4.56	759.02	400.16	0.38
Reach-1	17.6*	10.00	98.40	99.21	98.82	99.22	0.001298	1.02	9.78	17.78	0.24
Reach-1	17.6*	20.00	98.40	99.47	98.96	99.50	0.001546	1.35	14.80	20.13	0.28
Reach-1	17.6*	30.00	98.40	99.68	99.09	99.72	0.001684	1.56	19.23	22.45	0.30
Reach-1	17.6*	40.00	98.40	99.86	99.19	99.91	0.001776	1.70	23.57	25.24	0.31
Reach-1	17.6*	50.00	98.40	100.03	99.28	100.08	0.001733	1.79	27.90	27.00	0.31
Reach-1	17.6*	60.00	98.40	100.18	99.37	100.23	0.001651	1.88	31.98	27.81	0.31
Reach-1	17.6*	70.00	98.40	100.31	99.45	100.37	0.001576	1.95	35.85	28.24	0.31
Reach-1	17.6*	80.00	98.40	100.44	99.53	100.51	0.001525	2.03	39.49	28.63	0.30
Reach-1	17.6*	90.00	98.40	100.56	99.60	100.63	0.001493	2.10	42.91	29.00	0.30
Reach-1	17.6*	100.00	98.40	100.67	99.67	100.75	0.001470	2.16	46.20	29.34	0.30
Reach-1	17.6*	200.00	98.40	101.51	100.20	101.63	0.001456	2.76	80.13	89.64	0.32
Reach-1	17.6*	500.00	98.40	102.54	101.21	102.69	0.001512	3.59	279.28	298.12	0.35
Reach-1	17.6*	750.00	98.40	103.00	102.21	103.15	0.001522	3.93	438.77	391.93	0.36
Reach-1	17.6*	1000.00	98.40	103.31	102.57	103.46	0.001539	4.16	561.70	400.34	0.36
Reach-1	17.6*	1500.00	98.40	103.81	103.11	103.96	0.001563	4.53	761.96	400.34	0.37
Reach-1	17.4*	10.00	98.18	99.20	98.58	99.20	0.000504	0.77	12.96	17.52	0.16
Reach-1	17.4*	20.00	98.18	99.45	98.74	99.47	0.000812	1.13	17.74	19.36	0.21
Reach-1	17.4*	30.00	98.18	99.66	98.86	99.69	0.001007	1.37	21.87	20.86	0.24
Reach-1	17.4*	40.00	98.18	99.84	98.97	99.88	0.001179	1.55	25.75	22.93	0.26
Reach-1	17.4*	50.00	98.18	100.00	99.07	100.04	0.001308	1.69	29.65	25.25	0.27
Reach-1	17.4*	60.00	98.18	100.15	99.17	100.20	0.001373	1.79	33.55	27.12	0.28
Reach-1	17.4*	70.00	98.18	100.29	99.25	100.34	0.001358	1.87	37.36	27.87	0.29
Reach-1	17.4*	80.00	98.18	100.42	99.33	100.48	0.001341	1.95	40.98	28.42	0.29

Reach-1	17.4*	90.00	98.18	100.54	99.40	100.60	0.001334	2.03	44.40	28.90	0.29
Reach-1	17.4*	100.00	98.18	100.65	99.48	100.72	0.001330	2.10	47.68	29.36	0.29
Reach-1	17.4*	200.00	98.18	101.49	100.09	101.60	0.001367	2.69	82.87	93.04	0.31
Reach-1	17.4*	500.00	98.18	102.51	101.13	102.66	0.001439	3.52	284.37	299.88	0.34
Reach-1	17.4*	750.00	98.18	102.97	102.14	103.12	0.001464	3.87	443.88	392.76	0.35
Reach-1	17.4*	1000.00	98.18	103.28	102.51	103.43	0.001492	4.11	566.23	400.50	0.36
Reach-1	17.4*	1500.00	98.18	103.78	103.07	103.93	0.001528	4.49	766.07	400.50	0.37
Reach-1	17.2*	10.00	97.95	99.19	98.34	99.20	0.000253	0.63	15.88	17.14	0.12
Reach-1	17.2*	20.00	97.95	99.45	98.51	99.46	0.000489	0.98	20.44	18.65	0.16
Reach-1	17.2*	30.00	97.95	99.65	98.64	99.67	0.000673	1.23	24.34	19.90	0.20
Reach-1	17.2*	40.00	97.95	99.82	98.75	99.86	0.000815	1.43	27.92	20.98	0.22
Reach-1	17.2*	50.00	97.95	99.98	98.86	100.02	0.000970	1.59	31.39	22.92	0.24
Reach-1	17.2*	60.00	97.95	100.13	98.96	100.17	0.001097	1.72	34.86	24.89	0.26
Reach-1	17.2*	70.00	97.95	100.26	99.05	100.32	0.001190	1.82	38.40	26.74	0.27
Reach-1	17.2*	80.00	97.95	100.39	99.13	100.45	0.001224	1.91	41.91	27.80	0.27
Reach-1	17.2*	90.00	97.95	100.51	99.21	100.57	0.001242	1.99	45.26	28.49	0.28
Reach-1	17.2*	100.00	97.95	100.62	99.29	100.69	0.001256	2.06	48.50	29.11	0.28
Reach-1	17.2*	200.00	97.95	101.46	99.93	101.57	0.001341	2.65	84.24	94.71	0.31
Reach-1	17.2*	500.00	97.95	102.48	101.08	102.63	0.001412	3.47	287.30	301.70	0.33
Reach-1	17.2*	750.00	97.95	102.94	102.09	103.09	0.001441	3.82	447.32	394.57	0.34
Reach-1	17.2*	1000.00	97.95	103.25	102.47	103.39	0.001470	4.06	569.37	400.66	0.35
Reach-1	17.2*	1500.00	97.95	103.75	102.93	103.90	0.001511	4.44	768.87	400.66	0.36
Reach-1	17.*	10.00	97.72	99.19	98.10	99.19	0.000152	0.54	18.43	16.66	0.09
Reach-1	17.*	20.00	97.72	99.44	98.27	99.45	0.000332	0.88	22.79	17.95	0.14
Reach-1	17.*	30.00	97.72	99.64	98.42	99.66	0.000491	1.13	26.47	19.03	0.17
Reach-1	17.*	40.00	97.72	99.81	98.54	99.84	0.000627	1.34	29.84	19.97	0.19
Reach-1	17.*	50.00	97.72	99.97	98.65	100.00	0.000741	1.51	33.01	20.81	0.21
Reach-1	17.*	60.00	97.72	100.11	98.76	100.15	0.000884	1.66	36.10	22.63	0.23
Reach-1	17.*	70.00	97.72	100.24	98.85	100.29	0.001002	1.78	39.25	24.36	0.25
Reach-1	17.*	80.00	97.72	100.37	98.94	100.43	0.001100	1.89	42.43	25.99	0.26
Reach-1	17.*	90.00	97.72	100.49	99.03	100.55	0.001180	1.97	45.57	27.47	0.27
Reach-1	17.*	100.00	97.72	100.60	99.11	100.66	0.001221	2.05	48.70	28.38	0.28
Reach-1	17.*	200.00	97.72	101.43	99.77	101.54	0.001372	2.64	84.71	96.03	0.31
Reach-1	17.*	500.00	97.72	102.46	101.05	102.60	0.001416	3.43	289.42	303.47	0.33
Reach-1	17.*	750.00	97.72	102.92	102.06	103.06	0.001440	3.77	450.16	396.44	0.34
Reach-1	17.*	1000.00	97.72	103.22	102.41	103.36	0.001465	4.00	572.15	400.84	0.35
Reach-1	17.*	1500.00	97.72	103.72	102.89	103.87	0.001507	4.38	771.39	400.84	0.36
Reach-1	16.8	10.00	97.49	99.19	97.87	99.19	0.000105	0.49	20.49	16.12	0.08
Reach-1	16.8	20.00	97.49	99.44	98.06	99.45	0.000250	0.81	24.65	17.25	0.12
Reach-1	16.8	30.00	97.49	99.63	98.21	99.65	0.000391	1.07	28.14	18.20	0.15
Reach-1	16.8	40.00	97.49	99.80	98.34	99.83	0.000518	1.28	31.31	19.03	0.18
Reach-1	16.8	50.00	97.49	99.96	98.46	99.99	0.000631	1.46	34.28	19.78	0.20
Reach-1	16.8	60.00	97.49	100.10	98.57	100.14	0.000735	1.62	37.09	20.49	0.21
Reach-1	16.8	70.00	97.49	100.23	98.67	100.27	0.000867	1.75	39.89	22.14	0.23
Reach-1	16.8	80.00	97.49	100.35	98.76	100.40	0.000984	1.87	42.72	23.69	0.25
Reach-1	16.8	90.00	97.49	100.46	98.85	100.53	0.001088	1.98	45.52	25.14	0.26
Reach-1	16.8	100.00	97.49	100.57	98.94	100.64	0.001177	2.07	48.36	26.52	0.27
Reach-1	16.8	200.00	97.49	101.40	99.64	101.51	0.001471	2.66	83.97	96.36	0.31
Reach-1	16.8	500.00	97.49	102.43	101.08	102.57	0.001458	3.41	289.85	304.23	0.33
Reach-1	16.8	750.00	97.49	102.89	102.04	103.03	0.001467	3.73	451.06	397.09	0.34
Reach-1	16.8	1000.00	97.49	103.20	102.40	103.33	0.001486	3.96	573.07	401.00	0.35
Reach-1	16.8	1500.00	97.49	103.69	102.85	103.83	0.001523	4.33	772.19	401.00	0.36
Reach-1	16.6*	10.00	97.75	99.18	98.13	99.19	0.000156	0.54	18.51	17.32	0.09
Reach-1	16.6*	20.00	97.75	99.43	98.31	99.44	0.000339	0.87	22.92	18.69	0.14
Reach-1	16.6*	30.00	97.75	99.62	98.44	99.64	0.000501	1.13	26.64	19.80	0.17

Reach-1	16.6*	40.00	97.75	99.79	98.57	99.82	0.000638	1.33	30.03	20.76	0.20
Reach-1	16.6*	50.00	97.75	99.94	98.67	99.97	0.000785	1.50	33.28	22.44	0.22
Reach-1	16.6*	60.00	97.75	100.08	98.77	100.12	0.000921	1.64	36.50	24.26	0.24
Reach-1	16.6*	70.00	97.75	100.21	98.87	100.26	0.001031	1.76	39.76	25.97	0.25
Reach-1	16.6*	80.00	97.75	100.33	98.95	100.38	0.001114	1.86	43.03	27.47	0.26
Reach-1	16.6*	90.00	97.75	100.44	99.03	100.50	0.001156	1.95	46.22	28.27	0.27
Reach-1	16.6*	100.00	97.75	100.55	99.11	100.62	0.001189	2.03	49.33	28.98	0.27
Reach-1	16.6*	200.00	97.75	101.38	99.76	101.48	0.001320	2.62	85.99	98.46	0.30
Reach-1	16.6*	500.00	97.75	102.40	100.98	102.54	0.001381	3.42	292.27	304.98	0.33
Reach-1	16.6*	750.00	97.75	102.86	101.99	103.00	0.001412	3.76	452.81	396.53	0.34
Reach-1	16.6*	1000.00	97.75	103.16	102.36	103.30	0.001449	4.01	573.54	400.75	0.35
Reach-1	16.6*	1500.00	97.75	103.66	102.82	103.80	0.001495	4.40	772.61	400.75	0.36
Reach-1	16.4*	10.00	98.01	99.18	98.41	99.18	0.000292	0.64	15.62	18.54	0.12
Reach-1	16.4*	20.00	98.01	99.42	98.57	99.43	0.000555	0.99	20.27	20.30	0.17
Reach-1	16.4*	30.00	98.01	99.60	98.69	99.63	0.000767	1.24	24.24	21.97	0.21
Reach-1	16.4*	40.00	98.01	99.77	98.81	99.80	0.000959	1.43	28.03	24.28	0.23
Reach-1	16.4*	50.00	98.01	99.92	98.91	99.96	0.001098	1.57	31.80	26.37	0.25
Reach-1	16.4*	60.00	98.01	100.05	99.00	100.10	0.001159	1.69	35.50	27.49	0.26
Reach-1	16.4*	70.00	98.01	100.18	99.08	100.23	0.001183	1.79	39.10	28.13	0.27
Reach-1	16.4*	80.00	98.01	100.30	99.16	100.36	0.001197	1.88	42.55	28.62	0.27
Reach-1	16.4*	90.00	98.01	100.42	99.24	100.48	0.001211	1.96	45.83	29.08	0.28
Reach-1	16.4*	100.00	98.01	100.53	99.31	100.59	0.001223	2.04	49.02	29.52	0.28
Reach-1	16.4*	200.00	98.01	101.35	99.92	101.46	0.001303	2.65	85.40	98.13	0.30
Reach-1	16.4*	500.00	98.01	102.37	100.97	102.51	0.001392	3.47	289.89	303.87	0.33
Reach-1	16.4*	750.00	98.01	102.82	101.98	102.97	0.001429	3.83	449.41	395.78	0.34
Reach-1	16.4*	1000.00	98.01	103.12	102.34	103.27	0.001472	4.09	569.23	400.50	0.35
Reach-1	16.4*	1500.00	98.01	103.62	102.90	103.77	0.001512	4.47	768.78	400.50	0.37
Reach-1	16.2*	10.00	98.27	99.16	98.69	99.17	0.000822	0.85	11.71	19.77	0.20
Reach-1	16.2*	20.00	98.27	99.39	98.84	99.41	0.001249	1.21	16.55	22.71	0.25
Reach-1	16.2*	30.00	98.27	99.57	98.95	99.61	0.001500	1.43	20.99	25.68	0.28
Reach-1	16.2*	40.00	98.27	99.74	99.06	99.78	0.001538	1.58	25.27	26.99	0.29
Reach-1	16.2*	50.00	98.27	99.88	99.15	99.93	0.001527	1.71	29.32	27.81	0.29
Reach-1	16.2*	60.00	98.27	100.02	99.23	100.07	0.001494	1.81	33.14	28.18	0.29
Reach-1	16.2*	70.00	98.27	100.15	99.31	100.21	0.001464	1.90	36.81	28.52	0.30
Reach-1	16.2*	80.00	98.27	100.27	99.39	100.33	0.001441	1.99	40.30	28.84	0.30
Reach-1	16.2*	90.00	98.27	100.39	99.46	100.45	0.001428	2.06	43.60	29.15	0.30
Reach-1	16.2*	100.00	98.27	100.49	99.52	100.57	0.001418	2.14	46.78	29.43	0.30
Reach-1	16.2*	200.00	98.27	101.31	100.00	101.43	0.001433	2.75	82.24	96.36	0.32
Reach-1	16.2*	500.00	98.27	102.33	101.01	102.48	0.001484	3.56	285.27	302.88	0.34
Reach-1	16.2*	750.00	98.27	102.79	102.00	102.94	0.001502	3.91	444.98	395.72	0.35
Reach-1	16.2*	1000.00	98.27	103.09	102.35	103.24	0.001525	4.14	566.00	400.25	0.36
Reach-1	16.2*	1500.00	98.27	103.59	102.89	103.74	0.001554	4.51	765.46	400.25	0.37
Reach-1	16	10.00	98.53	99.08	98.98	99.13	0.008723	1.73	5.79	20.11	0.57
Reach-1	16	20.00	98.53	99.31	99.11	99.37	0.005444	1.83	10.96	24.57	0.48
Reach-1	16	30.00	98.53	99.50	99.21	99.56	0.004066	1.90	15.76	26.59	0.44
Reach-1	16	40.00	98.53	99.67	99.30	99.73	0.003257	1.96	20.37	27.68	0.40
Reach-1	16	50.00	98.53	99.82	99.37	99.89	0.002756	2.03	24.64	27.95	0.38
Reach-1	16	60.00	98.53	99.96	99.44	100.03	0.002466	2.10	28.57	28.21	0.37
Reach-1	16	70.00	98.53	100.10	99.50	100.17	0.002265	2.17	32.31	28.45	0.36
Reach-1	16	80.00	98.53	100.22	99.57	100.30	0.002126	2.23	35.85	28.67	0.35
Reach-1	16	90.00	98.53	100.33	99.62	100.42	0.002033	2.30	39.16	28.88	0.35
Reach-1	16	100.00	98.53	100.44	99.67	100.53	0.001963	2.36	42.33	29.08	0.35
Reach-1	16	200.00	98.53	101.26	100.11	101.40	0.001783	2.96	76.53	93.31	0.35
Reach-1	16	500.00	98.53	102.29	101.35	102.44	0.001667	3.68	279.50	301.70	0.36
Reach-1	16	750.00	98.53	102.75	102.03	102.90	0.001626	3.98	440.90	395.28	0.36
Reach-1	16	1000.00	98.53	103.06	102.36	103.21	0.001613	4.18	563.67	400.00	0.37

Reach-1	16	1500.00	98.53	103.56	102.86	103.71	0.001620	4.52	763.07	400.00	0.37
Reach-1	15.8*	10.00	98.31	98.95	98.78	98.99	0.005795	1.65	6.06	16.56	0.48
Reach-1	15.8*	20.00	98.31	99.22	98.93	99.27	0.004328	1.77	11.27	22.15	0.44
Reach-1	15.8*	30.00	98.31	99.43	99.06	99.48	0.003346	1.85	16.21	24.56	0.40
Reach-1	15.8*	40.00	98.31	99.61	99.16	99.67	0.002874	1.92	20.84	26.63	0.38
Reach-1	15.8*	50.00	98.31	99.77	99.25	99.83	0.002568	1.98	25.28	28.34	0.37
Reach-1	15.8*	60.00	98.31	99.92	99.32	99.98	0.002267	2.04	29.47	28.67	0.35
Reach-1	15.8*	70.00	98.31	100.06	99.39	100.12	0.002067	2.10	33.40	28.92	0.34
Reach-1	15.8*	80.00	98.31	100.18	99.46	100.25	0.001935	2.16	37.08	29.15	0.34
Reach-1	15.8*	90.00	98.31	100.30	99.52	100.38	0.001851	2.22	40.50	29.37	0.33
Reach-1	15.8*	100.00	98.31	100.41	99.58	100.49	0.001788	2.28	43.77	29.57	0.33
Reach-1	15.8*	200.00	98.31	101.23	100.03	101.36	0.001646	2.87	78.59	94.00	0.34
Reach-1	15.8*	500.00	98.31	102.26	101.14	102.41	0.001593	3.63	281.56	301.79	0.35
Reach-1	15.8*	750.00	98.31	102.72	101.98	102.87	0.001575	3.94	442.42	395.23	0.36
Reach-1	15.8*	1000.00	98.31	103.03	102.31	103.17	0.001575	4.15	564.80	400.16	0.36
Reach-1	15.8*	1500.00	98.31	103.52	102.82	103.67	0.001592	4.51	764.06	400.16	0.37
Reach-1	15.6*	10.00	98.08	98.90	98.54	98.92	0.001895	1.20	8.36	15.93	0.29
Reach-1	15.6*	20.00	98.08	99.17	98.71	99.20	0.002146	1.54	13.03	18.67	0.32
Reach-1	15.6*	30.00	98.08	99.38	98.84	99.42	0.002385	1.73	17.31	22.34	0.35
Reach-1	15.6*	40.00	98.08	99.56	98.96	99.62	0.002296	1.85	21.64	24.58	0.35
Reach-1	15.6*	50.00	98.08	99.73	99.06	99.78	0.002202	1.94	25.83	26.51	0.35
Reach-1	15.6*	60.00	98.08	99.88	99.15	99.94	0.002116	2.00	29.94	28.26	0.34
Reach-1	15.6*	70.00	98.08	100.02	99.24	100.08	0.001988	2.06	34.00	29.34	0.34
Reach-1	15.6*	80.00	98.08	100.15	99.33	100.22	0.001849	2.12	37.82	29.59	0.33
Reach-1	15.6*	90.00	98.08	100.27	99.40	100.34	0.001763	2.18	41.36	29.81	0.33
Reach-1	15.6*	100.00	98.08	100.38	99.46	100.46	0.001700	2.24	44.72	30.03	0.32
Reach-1	15.6*	200.00	98.08	101.21	99.99	101.33	0.001566	2.81	80.16	94.77	0.33
Reach-1	15.6*	500.00	98.08	102.23	100.99	102.38	0.001543	3.58	283.46	302.13	0.35
Reach-1	15.6*	750.00	98.08	102.69	101.91	102.84	0.001539	3.90	444.00	395.32	0.36
Reach-1	15.6*	1000.00	98.08	103.00	102.25	103.14	0.001547	4.12	566.11	400.34	0.36
Reach-1	15.6*	1500.00	98.08	103.49	102.78	103.64	0.001572	4.49	765.21	400.34	0.37
Reach-1	15.4*	10.00	97.85	98.88	98.30	98.90	0.000725	0.90	11.13	15.67	0.19
Reach-1	15.4*	20.00	97.85	99.15	98.48	99.17	0.001136	1.29	15.48	17.63	0.24
Reach-1	15.4*	30.00	97.85	99.35	98.62	99.39	0.001391	1.56	19.23	19.14	0.27
Reach-1	15.4*	40.00	97.85	99.53	98.74	99.57	0.001681	1.75	22.92	22.24	0.30
Reach-1	15.4*	50.00	97.85	99.69	98.85	99.74	0.001789	1.87	26.72	24.45	0.32
Reach-1	15.4*	60.00	97.85	99.84	98.95	99.90	0.001826	1.97	30.51	26.29	0.32
Reach-1	15.4*	70.00	97.85	99.98	99.04	100.04	0.001829	2.04	34.32	28.02	0.32
Reach-1	15.4*	80.00	97.85	100.11	99.12	100.18	0.001812	2.10	38.10	29.54	0.33
Reach-1	15.4*	90.00	97.85	100.23	99.20	100.30	0.001748	2.16	41.72	30.17	0.32
Reach-1	15.4*	100.00	97.85	100.35	99.27	100.42	0.001680	2.21	45.17	30.41	0.32
Reach-1	15.4*	200.00	97.85	101.18	99.90	101.29	0.001533	2.77	81.16	95.30	0.33
Reach-1	15.4*	500.00	97.85	102.20	100.93	102.35	0.001520	3.54	284.41	301.76	0.34
Reach-1	15.4*	750.00	97.85	102.66	101.87	102.81	0.001522	3.87	444.33	394.41	0.35
Reach-1	15.4*	1000.00	97.85	102.96	102.21	103.11	0.001539	4.10	566.05	400.50	0.36
Reach-1	15.4*	1500.00	97.85	103.46	102.75	103.61	0.001565	4.47	765.09	400.50	0.37
Reach-1	15.2*	10.00	97.63	98.88	98.06	98.89	0.000352	0.72	13.84	15.50	0.13
Reach-1	15.2*	20.00	97.63	99.13	98.24	99.15	0.000670	1.11	17.99	17.05	0.19
Reach-1	15.2*	30.00	97.63	99.33	98.39	99.36	0.000918	1.39	21.51	18.30	0.23
Reach-1	15.2*	40.00	97.63	99.51	98.52	99.55	0.001115	1.61	24.78	19.53	0.25
Reach-1	15.2*	50.00	97.63	99.66	98.64	99.71	0.001348	1.78	28.04	21.97	0.28
Reach-1	15.2*	60.00	97.63	99.81	98.74	99.87	0.001501	1.91	31.41	24.07	0.29
Reach-1	15.2*	70.00	97.63	99.95	98.83	100.01	0.001584	2.01	34.86	25.82	0.30
Reach-1	15.2*	80.00	97.63	100.08	98.92	100.14	0.001638	2.09	38.32	27.46	0.31
Reach-1	15.2*	90.00	97.63	100.20	99.01	100.27	0.001679	2.16	41.72	28.98	0.32

Reach-1	15.2*	100.00	97.63	100.31	99.09	100.39	0.001706	2.22	45.11	30.45	0.32
Reach-1	15.2*	200.00	97.63	101.15	99.78	101.26	0.001551	2.76	80.97	94.03	0.33
Reach-1	15.2*	500.00	97.63	102.17	100.89	102.31	0.001533	3.53	283.24	301.32	0.34
Reach-1	15.2*	750.00	97.63	102.63	101.84	102.77	0.001533	3.85	443.00	394.37	0.35
Reach-1	15.2*	1000.00	97.63	102.93	102.18	103.08	0.001550	4.08	564.52	400.66	0.36
Reach-1	15.2*	1500.00	97.63	103.43	102.72	103.58	0.001574	4.45	763.67	400.66	0.37
Reach-1	15.*	10.00	97.40	98.87	97.82	98.88	0.000202	0.61	16.39	15.30	0.10
Reach-1	15.*	20.00	97.40	99.13	98.02	99.14	0.000436	0.98	20.40	16.59	0.16
Reach-1	15.*	30.00	97.40	99.32	98.17	99.35	0.000646	1.26	23.74	17.65	0.19
Reach-1	15.*	40.00	97.40	99.49	98.30	99.52	0.000821	1.49	26.82	18.57	0.22
Reach-1	15.*	50.00	97.40	99.64	98.43	99.69	0.000969	1.68	29.73	19.43	0.24
Reach-1	15.*	60.00	97.40	99.79	98.53	99.84	0.001169	1.84	32.63	21.51	0.26
Reach-1	15.*	70.00	97.40	99.92	98.63	99.98	0.001327	1.96	35.66	23.50	0.28
Reach-1	15.*	80.00	97.40	100.05	98.73	100.11	0.001438	2.06	38.76	25.19	0.29
Reach-1	15.*	90.00	97.40	100.17	98.82	100.24	0.001528	2.15	41.83	26.75	0.30
Reach-1	15.*	100.00	97.40	100.28	98.90	100.35	0.001597	2.23	44.91	28.23	0.31
Reach-1	15.*	200.00	97.40	101.11	99.58	101.23	0.001616	2.77	80.61	93.98	0.33
Reach-1	15.*	500.00	97.40	102.14	100.89	102.28	0.001554	3.51	283.50	301.61	0.34
Reach-1	15.*	750.00	97.40	102.60	101.80	102.74	0.001546	3.82	443.52	394.65	0.35
Reach-1	15.*	1000.00	97.40	102.90	102.12	103.04	0.001560	4.05	564.95	400.84	0.36
Reach-1	15.*	1500.00	97.40	103.40	102.68	103.55	0.001581	4.41	764.12	400.84	0.37
Reach-1	14.8	10.00	97.18	98.87	97.59	98.88	0.000130	0.53	18.77	15.10	0.08
Reach-1	14.8	20.00	97.18	99.12	97.79	99.13	0.000307	0.88	22.67	16.22	0.13
Reach-1	14.8	30.00	97.18	99.31	97.95	99.33	0.000480	1.16	25.87	17.16	0.17
Reach-1	14.8	40.00	97.18	99.48	98.09	99.51	0.000636	1.39	28.81	17.97	0.19
Reach-1	14.8	50.00	97.18	99.63	98.21	99.67	0.000775	1.58	31.57	18.70	0.21
Reach-1	14.8	60.00	97.18	99.77	98.32	99.82	0.000898	1.75	34.20	19.37	0.23
Reach-1	14.8	70.00	97.18	99.90	98.43	99.95	0.001061	1.90	36.84	21.04	0.25
Reach-1	14.8	80.00	97.18	100.02	98.53	100.09	0.001208	2.02	39.55	22.72	0.27
Reach-1	14.8	90.00	97.18	100.14	98.62	100.21	0.001335	2.13	42.25	24.28	0.28
Reach-1	14.8	100.00	97.18	100.25	98.71	100.32	0.001444	2.22	44.99	25.77	0.30
Reach-1	14.8	200.00	97.18	101.08	99.44	101.20	0.001739	2.80	79.37	93.06	0.34
Reach-1	14.8	500.00	97.18	102.11	100.97	102.25	0.001601	3.50	282.95	301.66	0.35
Reach-1	14.8	750.00	97.18	102.57	101.78	102.71	0.001575	3.80	443.43	394.84	0.35
Reach-1	14.8	1000.00	97.18	102.87	102.11	103.01	0.001583	4.02	564.88	401.00	0.36
Reach-1	14.8	1500.00	97.18	103.37	102.55	103.51	0.001597	4.37	764.14	401.00	0.37
Reach-1	14.6*	10.00	97.44	98.87	97.86	98.87	0.000214	0.62	16.24	15.78	0.11
Reach-1	14.6*	20.00	97.44	99.11	98.05	99.12	0.000464	0.99	20.23	17.16	0.16
Reach-1	14.6*	30.00	97.44	99.30	98.20	99.32	0.000687	1.27	23.54	18.26	0.20
Reach-1	14.6*	40.00	97.44	99.46	98.33	99.49	0.000874	1.50	26.59	19.21	0.23
Reach-1	14.6*	50.00	97.44	99.61	98.45	99.65	0.001094	1.69	29.55	21.20	0.25
Reach-1	14.6*	60.00	97.44	99.74	98.55	99.79	0.001284	1.84	32.56	23.22	0.27
Reach-1	14.6*	70.00	97.44	99.87	98.65	99.93	0.001415	1.96	35.68	24.93	0.29
Reach-1	14.6*	80.00	97.44	99.99	98.74	100.06	0.001512	2.06	38.83	26.51	0.30
Reach-1	14.6*	90.00	97.44	100.11	98.83	100.18	0.001589	2.15	41.94	27.98	0.31
Reach-1	14.6*	100.00	97.44	100.22	98.91	100.29	0.001648	2.22	45.07	29.39	0.32
Reach-1	14.6*	200.00	97.44	101.05	99.62	101.16	0.001586	2.77	80.77	94.03	0.33
Reach-1	14.6*	500.00	97.44	102.07	100.81	102.22	0.001536	3.51	284.06	301.58	0.34
Reach-1	14.6*	750.00	97.44	102.53	101.74	102.68	0.001533	3.83	443.98	394.39	0.35
Reach-1	14.6*	1000.00	97.44	102.83	102.08	102.98	0.001555	4.07	564.68	400.75	0.36
Reach-1	14.6*	1500.00	97.44	103.33	102.62	103.48	0.001576	4.43	764.14	400.75	0.37
Reach-1	14.4*	10.00	97.69	98.86	98.14	98.87	0.000438	0.75	13.28	16.69	0.15
Reach-1	14.4*	20.00	97.69	99.09	98.32	99.11	0.000819	1.15	17.39	18.41	0.21
Reach-1	14.4*	30.00	97.69	99.27	98.46	99.30	0.001168	1.44	20.85	20.55	0.25
Reach-1	14.4*	40.00	97.69	99.43	98.58	99.47	0.001462	1.64	24.32	23.21	0.28

Reach-1	14.4*	50.00	97.69	99.57	98.69	99.62	0.001617	1.80	27.79	24.98	0.30
Reach-1	14.4*	60.00	97.69	99.71	98.78	99.76	0.001717	1.92	31.24	26.63	0.31
Reach-1	14.4*	70.00	97.69	99.84	98.88	99.90	0.001768	2.01	34.77	28.21	0.32
Reach-1	14.4*	80.00	97.69	99.96	98.96	100.03	0.001784	2.09	38.32	29.63	0.32
Reach-1	14.4*	90.00	97.69	100.07	99.04	100.15	0.001740	2.15	41.78	30.16	0.32
Reach-1	14.4*	100.00	97.69	100.18	99.12	100.26	0.001688	2.22	45.09	30.39	0.32
Reach-1	14.4*	200.00	97.69	101.01	99.74	101.13	0.001547	2.78	80.26	92.94	0.33
Reach-1	14.4*	500.00	97.69	102.04	100.75	102.18	0.001543	3.57	281.54	300.44	0.35
Reach-1	14.4*	750.00	97.69	102.50	101.71	102.64	0.001544	3.89	441.01	393.62	0.36
Reach-1	14.4*	1000.00	97.69	102.80	102.06	102.94	0.001572	4.14	560.94	400.50	0.36
Reach-1	14.4*	1500.00	97.69	103.30	102.60	103.45	0.001584	4.49	761.57	400.50	0.37
Reach-1	14.2*	10.00	97.95	98.84	98.42	98.85	0.001299	1.01	9.86	18.15	0.24
Reach-1	14.2*	20.00	97.95	99.06	98.58	99.09	0.001989	1.40	14.28	22.23	0.31
Reach-1	14.2*	30.00	97.95	99.23	98.71	99.27	0.002202	1.64	18.30	24.25	0.33
Reach-1	14.2*	40.00	97.95	99.38	98.82	99.43	0.002266	1.80	22.20	26.02	0.34
Reach-1	14.2*	50.00	97.95	99.53	98.92	99.58	0.002259	1.92	26.05	27.66	0.35
Reach-1	14.2*	60.00	97.95	99.66	99.01	99.72	0.002187	2.01	29.88	28.90	0.35
Reach-1	14.2*	70.00	97.95	99.79	99.09	99.86	0.002031	2.08	33.67	29.14	0.34
Reach-1	14.2*	80.00	97.95	99.92	99.16	99.99	0.001914	2.14	37.31	29.36	0.34
Reach-1	14.2*	90.00	97.95	100.03	99.22	100.11	0.001833	2.21	40.74	29.58	0.33
Reach-1	14.2*	100.00	97.95	100.14	99.28	100.22	0.001770	2.27	44.02	29.78	0.33
Reach-1	14.2*	200.00	97.95	100.98	99.76	101.10	0.001611	2.85	78.83	92.83	0.33
Reach-1	14.2*	500.00	97.95	102.00	100.80	102.15	0.001585	3.62	280.32	300.74	0.35
Reach-1	14.2*	750.00	97.95	102.46	101.71	102.61	0.001572	3.94	440.62	394.39	0.36
Reach-1	14.2*	1000.00	97.95	102.76	102.04	102.91	0.001585	4.17	561.76	400.25	0.37
Reach-1	14.2*	1500.00	97.95	103.26	102.56	103.42	0.001594	4.52	762.17	400.25	0.37
Reach-1	14	10.00	98.21	98.73	98.66	98.79	0.013149	1.99	5.03	19.26	0.69
Reach-1	14	20.00	98.21	98.95	98.79	99.01	0.007445	2.02	9.90	24.10	0.56
Reach-1	14	30.00	98.21	99.14	98.89	99.20	0.005072	2.05	14.65	26.14	0.48
Reach-1	14	40.00	98.21	99.31	98.98	99.37	0.003980	2.09	19.15	27.59	0.44
Reach-1	14	50.00	98.21	99.46	99.05	99.53	0.003264	2.14	23.38	27.87	0.41
Reach-1	14	60.00	98.21	99.60	99.12	99.67	0.002847	2.20	27.32	28.13	0.39
Reach-1	14	70.00	98.21	99.74	99.18	99.81	0.002542	2.25	31.17	28.37	0.38
Reach-1	14	80.00	98.21	99.86	99.24	99.95	0.002332	2.30	34.82	28.61	0.37
Reach-1	14	90.00	98.21	99.98	99.30	100.07	0.002194	2.35	38.23	28.82	0.36
Reach-1	14	100.00	98.21	100.09	99.35	100.18	0.002092	2.41	41.48	29.03	0.36
Reach-1	14	200.00	98.21	100.93	99.79	101.06	0.001824	2.98	75.32	90.64	0.35
Reach-1	14	500.00	98.21	101.96	101.03	102.12	0.001702	3.71	276.16	299.45	0.36
Reach-1	14	750.00	98.21	102.42	101.71	102.58	0.001651	4.00	437.56	393.86	0.37
Reach-1	14	1000.00	98.21	102.73	102.04	102.88	0.001637	4.20	560.37	400.00	0.37
Reach-1	14	1500.00	98.21	103.23	102.54	103.38	0.001633	4.54	760.75	400.00	0.38
Reach-1	13.8*	10.00	97.98	98.60	98.42	98.64	0.004508	1.48	6.75	17.92	0.43
Reach-1	13.8*	20.00	97.98	98.87	98.56	98.91	0.003413	1.68	11.94	21.40	0.40
Reach-1	13.8*	30.00	97.98	99.07	98.67	99.12	0.003093	1.80	16.69	24.98	0.39
Reach-1	13.8*	40.00	97.98	99.25	98.77	99.31	0.002645	1.87	21.36	26.70	0.37
Reach-1	13.8*	50.00	97.98	99.41	98.86	99.47	0.002335	1.94	25.75	27.72	0.35
Reach-1	13.8*	60.00	97.98	99.56	98.94	99.62	0.002103	2.01	29.85	28.06	0.34
Reach-1	13.8*	70.00	97.98	99.70	99.02	99.77	0.001928	2.07	33.81	28.39	0.33
Reach-1	13.8*	80.00	97.98	99.83	99.09	99.90	0.001809	2.13	37.56	28.70	0.33
Reach-1	13.8*	90.00	97.98	99.95	99.15	100.03	0.001734	2.19	41.04	28.98	0.32
Reach-1	13.8*	100.00	97.98	100.07	99.20	100.14	0.001679	2.25	44.36	29.25	0.32
Reach-1	13.8*	200.00	97.98	100.90	99.66	101.03	0.001567	2.84	79.01	92.20	0.33
Reach-1	13.8*	500.00	97.98	101.93	100.67	102.08	0.001569	3.63	279.75	299.73	0.35
Reach-1	13.8*	750.00	97.98	102.39	101.63	102.54	0.001559	3.95	440.27	393.54	0.36
Reach-1	13.8*	1000.00	97.98	102.70	101.97	102.85	0.001572	4.18	562.10	400.16	0.36
Reach-1	13.8*	1500.00	97.98	103.20	102.50	103.35	0.001587	4.53	762.22	400.16	0.37

Reach-1	13.6*	10.00	97.76	98.57	98.17	98.59	0.001239	1.01	9.94	17.87	0.24
Reach-1	13.6*	20.00	97.76	98.83	98.32	98.86	0.001511	1.34	14.93	20.23	0.27
Reach-1	13.6*	30.00	97.76	99.04	98.45	99.07	0.001700	1.56	19.21	22.53	0.30
Reach-1	13.6*	40.00	97.76	99.21	98.55	99.26	0.001801	1.70	23.49	25.27	0.31
Reach-1	13.6*	50.00	97.76	99.38	98.64	99.43	0.001757	1.80	27.79	27.00	0.31
Reach-1	13.6*	60.00	97.76	99.53	98.73	99.58	0.001669	1.88	31.88	27.82	0.31
Reach-1	13.6*	70.00	97.76	99.67	98.81	99.73	0.001570	1.95	35.90	28.27	0.30
Reach-1	13.6*	80.00	97.76	99.80	98.88	99.87	0.001504	2.02	39.68	28.67	0.30
Reach-1	13.6*	90.00	97.76	99.92	98.95	99.99	0.001465	2.08	43.19	29.04	0.30
Reach-1	13.6*	100.00	97.76	100.04	99.03	100.11	0.001438	2.15	46.54	29.39	0.30
Reach-1	13.6*	200.00	97.76	100.88	99.55	101.00	0.001413	2.73	82.00	93.98	0.32
Reach-1	13.6*	500.00	97.76	101.90	100.56	102.05	0.001478	3.56	283.24	300.50	0.34
Reach-1	13.6*	750.00	97.76	102.36	101.56	102.51	0.001493	3.90	443.26	393.80	0.35
Reach-1	13.6*	1000.00	97.76	102.67	101.92	102.81	0.001522	4.14	564.32	400.34	0.36
Reach-1	13.6*	1500.00	97.76	103.16	102.46	103.32	0.001551	4.52	764.04	400.34	0.37
Reach-1	13.4*	10.00	97.53	98.56	97.93	98.57	0.000478	0.76	13.20	17.61	0.15
Reach-1	13.4*	20.00	97.53	98.82	98.09	98.84	0.000785	1.11	17.95	19.44	0.20
Reach-1	13.4*	30.00	97.53	99.02	98.21	99.04	0.001001	1.37	21.92	20.88	0.24
Reach-1	13.4*	40.00	97.53	99.19	98.33	99.23	0.001181	1.55	25.73	22.91	0.26
Reach-1	13.4*	50.00	97.53	99.35	98.43	99.40	0.001311	1.69	29.60	25.17	0.27
Reach-1	13.4*	60.00	97.53	99.50	98.52	99.55	0.001379	1.79	33.49	27.08	0.28
Reach-1	13.4*	70.00	97.53	99.64	98.60	99.70	0.001346	1.87	37.45	27.87	0.28
Reach-1	13.4*	80.00	97.53	99.78	98.68	99.84	0.001317	1.94	41.21	28.44	0.28
Reach-1	13.4*	90.00	97.53	99.90	98.76	99.96	0.001304	2.01	44.72	28.93	0.29
Reach-1	13.4*	100.00	97.53	100.02	98.83	100.08	0.001296	2.08	48.07	29.39	0.29
Reach-1	13.4*	200.00	97.53	100.86	99.44	100.97	0.001328	2.66	84.28	95.79	0.31
Reach-1	13.4*	500.00	97.53	101.88	100.49	102.02	0.001421	3.50	286.35	301.50	0.34
Reach-1	13.4*	750.00	97.53	102.33	101.50	102.48	0.001450	3.85	446.10	394.36	0.35
Reach-1	13.4*	1000.00	97.53	102.64	101.87	102.78	0.001489	4.11	566.56	400.50	0.36
Reach-1	13.4*	1500.00	97.53	103.13	102.42	103.29	0.001527	4.49	765.95	400.50	0.37
Reach-1	13.2*	10.00	97.30	98.56	97.69	98.56	0.000242	0.62	16.12	17.22	0.11
Reach-1	13.2*	20.00	97.30	98.81	97.86	98.82	0.000475	0.97	20.66	18.73	0.16
Reach-1	13.2*	30.00	97.30	99.00	97.99	99.03	0.000669	1.23	24.39	19.92	0.20
Reach-1	13.2*	40.00	97.30	99.18	98.11	99.21	0.000816	1.43	27.90	20.98	0.22
Reach-1	13.2*	50.00	97.30	99.33	98.21	99.37	0.000972	1.60	31.35	22.89	0.24
Reach-1	13.2*	60.00	97.30	99.48	98.31	99.52	0.001097	1.72	34.83	24.83	0.26
Reach-1	13.2*	70.00	97.30	99.62	98.40	99.67	0.001178	1.82	38.51	26.72	0.27
Reach-1	13.2*	80.00	97.30	99.75	98.48	99.81	0.001202	1.90	42.16	27.83	0.27
Reach-1	13.2*	90.00	97.30	99.88	98.56	99.94	0.001213	1.97	45.60	28.53	0.28
Reach-1	13.2*	100.00	97.30	99.99	98.64	100.06	0.001224	2.04	48.92	29.16	0.28
Reach-1	13.2*	200.00	97.30	100.83	99.28	100.94	0.001301	2.62	85.76	97.63	0.30
Reach-1	13.2*	500.00	97.30	101.85	100.44	101.99	0.001393	3.45	289.40	303.38	0.33
Reach-1	13.2*	750.00	97.30	102.31	101.45	102.45	0.001426	3.80	449.61	396.17	0.34
Reach-1	13.2*	1000.00	97.30	102.61	101.82	102.75	0.001467	4.05	569.74	400.66	0.35
Reach-1	13.2*	1500.00	97.30	103.10	102.41	103.25	0.001511	4.44	768.76	400.66	0.36
Reach-1	13.*	10.00	97.08	98.55	97.46	98.56	0.000149	0.54	18.54	16.69	0.09
Reach-1	13.*	20.00	97.08	98.80	97.63	98.82	0.000329	0.87	22.86	17.97	0.14
Reach-1	13.*	30.00	97.08	98.99	97.78	99.01	0.000496	1.14	26.38	19.01	0.17
Reach-1	13.*	40.00	97.08	99.16	97.90	99.19	0.000637	1.35	29.67	19.92	0.19
Reach-1	13.*	50.00	97.08	99.32	98.01	99.35	0.000753	1.52	32.82	20.76	0.21
Reach-1	13.*	60.00	97.08	99.46	98.12	99.50	0.000895	1.67	35.90	22.52	0.23
Reach-1	13.*	70.00	97.08	99.60	98.21	99.65	0.001007	1.79	39.18	24.33	0.25
Reach-1	13.*	80.00	97.08	99.73	98.30	99.79	0.001096	1.88	42.49	26.03	0.26
Reach-1	13.*	90.00	97.08	99.85	98.39	99.91	0.001169	1.97	45.73	27.53	0.27
Reach-1	13.*	100.00	97.08	99.97	98.47	100.03	0.001205	2.04	48.93	28.45	0.27

Reach-1	13.*	200.00	97.08	100.81	99.13	100.91	0.001340	2.62	86.08	98.85	0.30
Reach-1	13.*	500.00	97.08	101.82	100.41	101.96	0.001405	3.42	290.86	304.42	0.33
Reach-1	13.*	750.00	97.08	102.28	101.42	102.42	0.001432	3.76	451.33	396.93	0.34
Reach-1	13.*	1000.00	97.08	102.58	101.77	102.72	0.001471	4.01	571.20	400.84	0.35
Reach-1	13.*	1500.00	97.08	103.08	102.25	103.22	0.001515	4.39	769.99	400.84	0.36
Reach-1	12.8	10.00	96.85	98.55	97.23	98.56	0.000103	0.49	20.61	16.15	0.08
Reach-1	12.8	20.00	96.85	98.80	97.42	98.81	0.000248	0.81	24.73	17.27	0.12
Reach-1	12.8	30.00	96.85	98.99	97.57	99.01	0.000394	1.07	28.05	18.18	0.15
Reach-1	12.8	40.00	96.85	99.15	97.70	99.18	0.000525	1.28	31.15	18.99	0.18
Reach-1	12.8	50.00	96.85	99.31	97.82	99.34	0.000641	1.47	34.10	19.73	0.20
Reach-1	12.8	60.00	96.85	99.45	97.93	99.49	0.000743	1.63	36.91	20.41	0.21
Reach-1	12.8	70.00	96.85	99.58	98.03	99.63	0.000870	1.76	39.82	22.10	0.23
Reach-1	12.8	80.00	96.85	99.71	98.12	99.77	0.000981	1.87	42.77	23.72	0.25
Reach-1	12.8	90.00	96.85	99.83	98.21	99.89	0.001080	1.97	45.67	25.21	0.26
Reach-1	12.8	100.00	96.85	99.94	98.30	100.01	0.001165	2.06	48.58	26.62	0.27
Reach-1	12.8	200.00	96.85	100.78	99.00	100.88	0.001435	2.64	85.42	99.36	0.31
Reach-1	12.8	500.00	96.85	101.80	100.44	101.93	0.001445	3.40	291.38	305.24	0.33
Reach-1	12.8	750.00	96.85	102.25	101.40	102.39	0.001459	3.73	452.30	397.40	0.34
Reach-1	12.8	1000.00	96.85	102.55	101.76	102.69	0.001493	3.97	572.05	401.00	0.35
Reach-1	12.8	1500.00	96.85	103.05	102.21	103.19	0.001531	4.34	770.71	401.00	0.36
Reach-1	12.6*	10.00	97.11	98.55	97.49	98.55	0.000153	0.54	18.62	17.34	0.09
Reach-1	12.6*	20.00	97.11	98.79	97.67	98.80	0.000336	0.87	22.99	18.70	0.14
Reach-1	12.6*	30.00	97.11	98.98	97.80	99.00	0.000507	1.13	26.52	19.76	0.17
Reach-1	12.6*	40.00	97.11	99.14	97.93	99.17	0.000650	1.34	29.83	20.70	0.20
Reach-1	12.6*	50.00	97.11	99.29	98.04	99.32	0.000798	1.51	33.03	22.30	0.22
Reach-1	12.6*	60.00	97.11	99.43	98.13	99.47	0.000936	1.66	36.25	24.13	0.24
Reach-1	12.6*	70.00	97.11	99.56	98.23	99.61	0.001038	1.77	39.65	25.93	0.25
Reach-1	12.6*	80.00	97.11	99.69	98.31	99.75	0.001111	1.86	43.08	27.48	0.26
Reach-1	12.6*	90.00	97.11	99.81	98.39	99.87	0.001146	1.94	46.36	28.30	0.27
Reach-1	12.6*	100.00	97.11	99.92	98.47	99.98	0.001174	2.02	49.56	29.02	0.27
Reach-1	12.6*	200.00	97.11	100.75	99.12	100.86	0.001294	2.61	86.79	99.66	0.30
Reach-1	12.6*	500.00	97.11	101.76	100.34	101.90	0.001388	3.43	290.81	304.23	0.33
Reach-1	12.6*	750.00	97.11	102.22	101.36	102.36	0.001428	3.78	450.08	396.31	0.34
Reach-1	12.6*	1000.00	97.11	102.51	101.73	102.66	0.001479	4.05	568.43	400.75	0.35
Reach-1	12.6*	1500.00	97.11	103.01	102.28	103.16	0.001522	4.43	767.29	400.75	0.36
Reach-1	12.4*	10.00	97.38	98.54	97.78	98.55	0.000292	0.64	15.63	18.54	0.12
Reach-1	12.4*	20.00	97.38	98.78	97.94	98.80	0.000559	0.99	20.22	20.27	0.17
Reach-1	12.4*	30.00	97.38	98.96	98.06	98.98	0.000787	1.25	23.96	21.78	0.21
Reach-1	12.4*	40.00	97.38	99.12	98.17	99.15	0.000995	1.45	27.63	24.08	0.24
Reach-1	12.4*	50.00	97.38	99.27	98.27	99.31	0.001143	1.60	31.34	26.19	0.26
Reach-1	12.4*	60.00	97.38	99.40	98.36	99.45	0.001207	1.71	35.03	27.41	0.27
Reach-1	12.4*	70.00	97.38	99.54	98.45	99.59	0.001211	1.80	38.80	28.11	0.27
Reach-1	12.4*	80.00	97.38	99.67	98.53	99.72	0.001208	1.89	42.43	28.63	0.27
Reach-1	12.4*	90.00	97.38	99.78	98.60	99.84	0.001213	1.96	45.82	29.10	0.28
Reach-1	12.4*	100.00	97.38	99.90	98.68	99.96	0.001219	2.04	49.09	29.55	0.28
Reach-1	12.4*	200.00	97.38	100.73	99.29	100.83	0.001280	2.63	86.78	101.29	0.30
Reach-1	12.4*	500.00	97.38	101.73	100.33	101.87	0.001385	3.47	291.15	304.83	0.33
Reach-1	12.4*	750.00	97.38	102.19	101.34	102.33	0.001427	3.83	450.24	396.03	0.34
Reach-1	12.4*	1000.00	97.38	102.48	101.71	102.63	0.001476	4.09	568.85	400.50	0.35
Reach-1	12.4*	1500.00	97.38	102.98	102.26	103.13	0.001523	4.48	767.10	400.50	0.37
Reach-1	12.2*	10.00	97.64	98.53	98.06	98.54	0.000831	0.86	11.67	19.81	0.20
Reach-1	12.2*	20.00	97.64	98.76	98.21	98.78	0.001271	1.22	16.46	22.70	0.25
Reach-1	12.2*	30.00	97.64	98.93	98.32	98.96	0.001573	1.46	20.61	25.43	0.28
Reach-1	12.2*	40.00	97.64	99.08	98.43	99.13	0.001641	1.62	24.74	26.88	0.30
Reach-1	12.2*	50.00	97.64	99.23	98.52	99.28	0.001627	1.74	28.74	27.76	0.30

Reach-1	12.2*	60.00	97.64	99.37	98.60	99.42	0.001579	1.84	32.57	28.13	0.30
Reach-1	12.2*	70.00	97.64	99.50	98.68	99.56	0.001512	1.92	36.44	28.49	0.30
Reach-1	12.2*	80.00	97.64	99.63	98.75	99.69	0.001462	1.99	40.12	28.84	0.30
Reach-1	12.2*	90.00	97.64	99.75	98.82	99.82	0.001436	2.07	43.54	29.15	0.30
Reach-1	12.2*	100.00	97.64	99.86	98.89	99.93	0.001417	2.14	46.80	29.45	0.30
Reach-1	12.2*	200.00	97.64	100.69	99.37	100.80	0.001409	2.74	83.56	99.45	0.32
Reach-1	12.2*	500.00	97.64	101.69	100.38	101.84	0.001482	3.56	285.91	303.05	0.34
Reach-1	12.2*	750.00	97.64	102.15	101.36	102.30	0.001506	3.91	444.62	395.12	0.35
Reach-1	12.2*	1000.00	97.64	102.45	101.71	102.60	0.001539	4.16	564.14	400.25	0.36
Reach-1	12.2*	1500.00	97.64	102.94	102.25	103.10	0.001572	4.53	762.37	400.25	0.37
Reach-1	12	10.00	97.90	98.45	98.35	98.50	0.009285	1.76	5.67	19.97	0.58
Reach-1	12	20.00	97.90	98.67	98.48	98.73	0.005841	1.87	10.71	24.46	0.50
Reach-1	12	30.00	97.90	98.85	98.58	98.91	0.004631	1.99	15.10	26.32	0.46
Reach-1	12	40.00	97.90	99.01	98.67	99.08	0.003722	2.05	19.55	27.62	0.43
Reach-1	12	50.00	97.90	99.16	98.74	99.23	0.003079	2.10	23.81	27.90	0.40
Reach-1	12	60.00	97.90	99.31	98.81	99.38	0.002694	2.16	27.79	28.16	0.38
Reach-1	12	70.00	97.90	99.45	98.87	99.52	0.002384	2.20	31.80	28.42	0.37
Reach-1	12	80.00	97.90	99.58	98.93	99.66	0.002181	2.25	35.56	28.65	0.36
Reach-1	12	90.00	97.90	99.70	98.99	99.78	0.002059	2.31	39.00	28.87	0.35
Reach-1	12	100.00	97.90	99.81	99.04	99.90	0.001972	2.37	42.27	29.08	0.35
Reach-1	12	200.00	97.90	100.64	99.48	100.77	0.001764	2.95	77.10	94.53	0.35
Reach-1	12	500.00	97.90	101.65	100.72	101.81	0.001695	3.71	276.80	299.88	0.36
Reach-1	12	750.00	97.90	102.11	101.40	102.26	0.001661	4.01	436.26	393.19	0.37
Reach-1	12	1000.00	97.90	102.42	101.73	102.57	0.001657	4.22	557.68	400.00	0.37
Reach-1	12	1500.00	97.90	102.91	102.23	103.06	0.001660	4.57	756.35	400.00	0.38
Reach-1	11.8*	10.00	97.67	98.31	98.14	98.35	0.006006	1.67	5.99	16.50	0.49
Reach-1	11.8*	20.00	97.67	98.57	98.30	98.62	0.004660	1.82	10.97	21.88	0.45
Reach-1	11.8*	30.00	97.67	98.76	98.42	98.82	0.003875	1.95	15.40	24.16	0.43
Reach-1	11.8*	40.00	97.67	98.94	98.53	99.00	0.003273	2.01	19.91	26.20	0.41
Reach-1	11.8*	50.00	97.67	99.11	98.61	99.17	0.002864	2.05	24.36	28.04	0.39
Reach-1	11.8*	60.00	97.67	99.26	98.69	99.33	0.002482	2.09	28.65	28.63	0.37
Reach-1	11.8*	70.00	97.67	99.41	98.76	99.48	0.002165	2.13	32.92	28.90	0.35
Reach-1	11.8*	80.00	97.67	99.54	98.82	99.61	0.001971	2.17	36.87	29.14	0.34
Reach-1	11.8*	90.00	97.67	99.66	98.89	99.74	0.001860	2.23	40.45	29.37	0.33
Reach-1	11.8*	100.00	97.67	99.78	98.94	99.86	0.001782	2.28	43.82	29.57	0.33
Reach-1	11.8*	200.00	97.67	100.61	99.40	100.73	0.001619	2.86	79.34	95.37	0.33
Reach-1	11.8*	500.00	97.67	101.62	100.50	101.77	0.001617	3.65	278.80	299.86	0.36
Reach-1	11.8*	750.00	97.67	102.08	101.34	102.23	0.001606	3.97	437.67	392.79	0.36
Reach-1	11.8*	1000.00	97.67	102.38	101.67	102.53	0.001620	4.20	558.33	400.16	0.37
Reach-1	11.8*	1500.00	97.67	102.88	102.19	103.03	0.001633	4.56	756.95	400.16	0.38
Reach-1	11.6*	10.00	97.44	98.26	97.91	98.28	0.001875	1.19	8.38	15.89	0.29
Reach-1	11.6*	20.00	97.44	98.52	98.07	98.56	0.002253	1.56	12.79	18.49	0.33
Reach-1	11.6*	30.00	97.44	98.70	98.21	98.76	0.002684	1.82	16.50	21.65	0.37
Reach-1	11.6*	40.00	97.44	98.89	98.32	98.95	0.002595	1.93	20.72	24.17	0.37
Reach-1	11.6*	50.00	97.44	99.06	98.42	99.12	0.002427	2.00	24.95	26.14	0.36
Reach-1	11.6*	60.00	97.44	99.21	98.51	99.28	0.002279	2.06	29.16	27.96	0.36
Reach-1	11.6*	70.00	97.44	99.37	98.60	99.43	0.002066	2.08	33.59	29.31	0.34
Reach-1	11.6*	80.00	97.44	99.51	98.69	99.58	0.001865	2.12	37.72	29.58	0.33
Reach-1	11.6*	90.00	97.44	99.63	98.76	99.70	0.001753	2.17	41.43	29.81	0.32
Reach-1	11.6*	100.00	97.44	99.75	98.83	99.82	0.001677	2.23	44.91	30.03	0.32
Reach-1	11.6*	200.00	97.44	100.58	99.35	100.70	0.001530	2.79	81.15	96.52	0.33
Reach-1	11.6*	500.00	97.44	101.59	100.33	101.74	0.001560	3.60	281.29	300.92	0.35
Reach-1	11.6*	750.00	97.44	102.05	101.28	102.20	0.001562	3.93	440.27	393.81	0.36
Reach-1	11.6*	1000.00	97.44	102.35	101.62	102.50	0.001584	4.16	560.58	400.34	0.36
Reach-1	11.6*	1500.00	97.44	102.84	102.15	103.00	0.001606	4.53	759.03	400.34	0.37

Reach-1	11.4*	10.00	97.21	98.25	97.66	98.26	0.000716	0.89	11.17	15.69	0.19
Reach-1	11.4*	20.00	97.21	98.49	97.84	98.52	0.001177	1.31	15.29	17.55	0.25
Reach-1	11.4*	30.00	97.21	98.67	97.98	98.71	0.001543	1.62	18.53	18.87	0.29
Reach-1	11.4*	40.00	97.21	98.85	98.10	98.90	0.001828	1.81	22.08	21.57	0.32
Reach-1	11.4*	50.00	97.21	99.02	98.21	99.07	0.001941	1.93	25.90	24.03	0.33
Reach-1	11.4*	60.00	97.21	99.17	98.31	99.23	0.001945	2.01	29.78	25.95	0.33
Reach-1	11.4*	70.00	97.21	99.33	98.40	99.39	0.001879	2.06	33.97	27.86	0.33
Reach-1	11.4*	80.00	97.21	99.47	98.48	99.54	0.001816	2.10	38.07	29.53	0.33
Reach-1	11.4*	90.00	97.21	99.60	98.56	99.67	0.001727	2.15	41.88	30.18	0.32
Reach-1	11.4*	100.00	97.21	99.71	98.63	99.79	0.001646	2.20	45.46	30.43	0.32
Reach-1	11.4*	200.00	97.21	100.56	99.26	100.67	0.001484	2.74	83.03	99.18	0.32
Reach-1	11.4*	500.00	97.21	101.56	100.29	101.71	0.001513	3.54	285.09	302.21	0.34
Reach-1	11.4*	750.00	97.21	102.02	101.23	102.17	0.001524	3.87	444.12	394.30	0.35
Reach-1	11.4*	1000.00	97.21	102.32	101.57	102.47	0.001553	4.12	563.96	400.50	0.36
Reach-1	11.4*	1500.00	97.21	102.81	102.11	102.96	0.001582	4.49	762.14	400.50	0.37
Reach-1	11.2*	10.00	96.99	98.24	97.42	98.25	0.000345	0.72	13.94	15.56	0.13
Reach-1	11.2*	20.00	96.99	98.48	97.60	98.50	0.000684	1.12	17.87	17.02	0.19
Reach-1	11.2*	30.00	96.99	98.65	97.75	98.69	0.000996	1.44	20.90	18.08	0.24
Reach-1	11.2*	40.00	96.99	98.83	97.88	98.87	0.001192	1.66	24.10	19.14	0.26
Reach-1	11.2*	50.00	96.99	98.99	97.99	99.04	0.001417	1.83	27.35	21.42	0.29
Reach-1	11.2*	60.00	96.99	99.14	98.10	99.20	0.001573	1.95	30.79	23.71	0.30
Reach-1	11.2*	70.00	96.99	99.29	98.19	99.36	0.001614	2.02	34.61	25.71	0.31
Reach-1	11.2*	80.00	96.99	99.44	98.28	99.50	0.001634	2.08	38.40	27.55	0.31
Reach-1	11.2*	90.00	96.99	99.56	98.37	99.63	0.001655	2.14	42.01	29.17	0.31
Reach-1	11.2*	100.00	96.99	99.68	98.45	99.76	0.001663	2.20	45.55	30.60	0.32
Reach-1	11.2*	200.00	96.99	100.53	99.14	100.64	0.001484	2.72	83.76	100.15	0.32
Reach-1	11.2*	500.00	96.99	101.53	100.25	101.68	0.001501	3.50	287.01	303.58	0.34
Reach-1	11.2*	750.00	96.99	101.99	101.19	102.13	0.001511	3.83	446.56	395.72	0.35
Reach-1	11.2*	1000.00	96.99	102.29	101.54	102.43	0.001540	4.07	566.14	400.66	0.36
Reach-1	11.2*	1500.00	96.99	102.78	102.07	102.93	0.001573	4.44	764.10	400.66	0.37
Reach-1	11.*	10.00	96.76	98.24	97.18	98.24	0.000196	0.60	16.55	15.37	0.10
Reach-1	11.*	20.00	96.76	98.47	97.37	98.49	0.000441	0.98	20.34	16.59	0.16
Reach-1	11.*	30.00	96.76	98.64	97.52	98.67	0.000689	1.29	23.20	17.50	0.20
Reach-1	11.*	40.00	96.76	98.81	97.66	98.85	0.000874	1.53	26.22	18.41	0.23
Reach-1	11.*	50.00	96.76	98.97	97.78	99.01	0.001018	1.71	29.19	19.26	0.25
Reach-1	11.*	60.00	96.76	99.12	97.89	99.17	0.001204	1.87	32.16	21.22	0.27
Reach-1	11.*	70.00	96.76	99.27	97.99	99.33	0.001337	1.97	35.55	23.45	0.28
Reach-1	11.*	80.00	96.76	99.41	98.08	99.47	0.001420	2.05	38.97	25.29	0.29
Reach-1	11.*	90.00	96.76	99.53	98.17	99.60	0.001490	2.13	42.24	26.91	0.30
Reach-1	11.*	100.00	96.76	99.65	98.25	99.72	0.001545	2.20	45.48	28.42	0.31
Reach-1	11.*	200.00	96.76	100.50	98.94	100.61	0.001530	2.72	83.79	100.76	0.32
Reach-1	11.*	500.00	96.76	101.51	100.25	101.64	0.001512	3.47	288.27	304.85	0.34
Reach-1	11.*	750.00	96.76	101.96	101.16	102.10	0.001514	3.79	448.48	397.03	0.35
Reach-1	11.*	1000.00	96.76	102.26	101.50	102.40	0.001540	4.03	567.99	400.84	0.36
Reach-1	11.*	1500.00	96.76	102.75	102.03	102.90	0.001572	4.40	765.81	400.84	0.37
Reach-1	10.8	10.00	96.53	98.23	96.94	98.24	0.000126	0.53	18.98	15.16	0.08
Reach-1	10.8	20.00	96.53	98.47	97.14	98.48	0.000307	0.88	22.65	16.22	0.13
Reach-1	10.8	30.00	96.53	98.63	97.30	98.65	0.000506	1.18	25.38	17.01	0.17
Reach-1	10.8	40.00	96.53	98.80	97.44	98.83	0.000671	1.42	28.26	17.82	0.20
Reach-1	10.8	50.00	96.53	98.95	97.56	98.99	0.000809	1.61	31.08	18.57	0.22
Reach-1	10.8	60.00	96.53	99.10	97.67	99.15	0.000926	1.77	33.81	19.27	0.24
Reach-1	10.8	70.00	96.53	99.25	97.78	99.30	0.001064	1.90	36.78	21.00	0.25
Reach-1	10.8	80.00	96.53	99.38	97.88	99.45	0.001193	2.01	39.78	22.86	0.27
Reach-1	10.8	90.00	96.53	99.51	97.97	99.57	0.001307	2.11	42.69	24.52	0.28
Reach-1	10.8	100.00	96.53	99.62	98.06	99.69	0.001403	2.19	45.59	26.08	0.29
Reach-1	10.8	200.00	96.53	100.46	98.79	100.58	0.001630	2.74	82.89	100.42	0.33

Reach-1	10.8	500.00	96.53	101.48	100.32	101.61	0.001551	3.45	288.17	305.13	0.34
Reach-1	10.8	750.00	96.53	101.93	101.13	102.07	0.001539	3.76	448.70	397.27	0.35
Reach-1	10.8	1000.00	96.53	102.23	101.46	102.37	0.001560	3.99	568.18	401.00	0.35
Reach-1	10.8	1500.00	96.53	102.72	101.90	102.87	0.001587	4.36	765.98	401.00	0.36
Reach-1	10.6*	10.00	96.79	98.23	97.21	98.24	0.000208	0.61	16.42	15.84	0.11
Reach-1	10.6*	20.00	96.79	98.46	97.40	98.47	0.000467	0.99	20.17	17.13	0.16
Reach-1	10.6*	30.00	96.79	98.62	97.55	98.64	0.000736	1.31	22.94	18.04	0.20
Reach-1	10.6*	40.00	96.79	98.78	97.69	98.81	0.000935	1.54	25.92	18.97	0.23
Reach-1	10.6*	50.00	96.79	98.93	97.80	98.97	0.001138	1.73	28.89	20.64	0.26
Reach-1	10.6*	60.00	96.79	99.07	97.91	99.12	0.001328	1.88	31.97	22.75	0.28
Reach-1	10.6*	70.00	96.79	99.22	98.00	99.28	0.001429	1.97	35.48	24.75	0.29
Reach-1	10.6*	80.00	96.79	99.35	98.10	99.42	0.001493	2.05	38.98	26.51	0.30
Reach-1	10.6*	90.00	96.79	99.48	98.18	99.55	0.001551	2.13	42.31	28.09	0.31
Reach-1	10.6*	100.00	96.79	99.59	98.27	99.67	0.001596	2.19	45.62	29.58	0.31
Reach-1	10.6*	200.00	96.79	100.43	98.97	100.55	0.001503	2.72	83.61	99.77	0.32
Reach-1	10.6*	500.00	96.79	101.44	100.16	101.58	0.001514	3.49	286.35	303.42	0.34
Reach-1	10.6*	750.00	96.79	101.89	101.10	102.04	0.001523	3.82	445.48	395.61	0.35
Reach-1	10.6*	1000.00	96.79	102.19	101.44	102.33	0.001558	4.07	564.07	400.75	0.36
Reach-1	10.6*	1500.00	96.79	102.69	101.97	102.83	0.001586	4.44	762.23	400.75	0.37
Reach-1	10.4*	10.00	97.06	98.22	97.50	98.23	0.000437	0.75	13.30	16.71	0.15
Reach-1	10.4*	20.00	97.06	98.44	97.68	98.46	0.000857	1.17	17.12	18.32	0.21
Reach-1	10.4*	30.00	97.06	98.59	97.82	98.62	0.001293	1.51	19.92	19.79	0.26
Reach-1	10.4*	40.00	97.06	98.74	97.95	98.79	0.001640	1.72	23.20	22.49	0.30
Reach-1	10.4*	50.00	97.06	98.89	98.05	98.95	0.001796	1.87	26.69	24.46	0.32
Reach-1	10.4*	60.00	97.06	99.03	98.15	99.09	0.001868	1.98	30.26	26.19	0.33
Reach-1	10.4*	70.00	97.06	99.18	98.24	99.24	0.001836	2.04	34.29	28.02	0.33
Reach-1	10.4*	80.00	97.06	99.32	98.32	99.39	0.001792	2.09	38.27	29.62	0.32
Reach-1	10.4*	90.00	97.06	99.44	98.40	99.51	0.001714	2.14	41.98	30.18	0.32
Reach-1	10.4*	100.00	97.06	99.56	98.48	99.63	0.001643	2.20	45.49	30.42	0.32
Reach-1	10.4*	200.00	97.06	100.40	99.10	100.52	0.001477	2.74	82.95	98.74	0.32
Reach-1	10.4*	500.00	97.06	101.40	100.12	101.55	0.001531	3.56	283.02	301.47	0.35
Reach-1	10.4*	750.00	97.06	101.86	101.08	102.00	0.001544	3.89	441.08	393.68	0.36
Reach-1	10.4*	1000.00	97.06	102.15	101.42	102.30	0.001588	4.15	558.72	400.50	0.36
Reach-1	10.4*	1500.00	97.06	102.65	101.96	102.80	0.001605	4.51	758.14	400.50	0.37
Reach-1	10.2*	10.00	97.32	98.20	97.78	98.21	0.001312	1.02	9.83	18.14	0.24
Reach-1	10.2*	20.00	97.32	98.40	97.95	98.43	0.002145	1.45	13.83	21.75	0.32
Reach-1	10.2*	30.00	97.32	98.54	98.08	98.58	0.002762	1.78	16.90	23.55	0.37
Reach-1	10.2*	40.00	97.32	98.69	98.18	98.74	0.002807	1.94	20.58	25.31	0.38
Reach-1	10.2*	50.00	97.32	98.84	98.28	98.90	0.002687	2.04	24.50	27.06	0.38
Reach-1	10.2*	60.00	97.32	98.98	98.37	99.05	0.002531	2.10	28.52	28.71	0.37
Reach-1	10.2*	70.00	97.32	99.13	98.45	99.20	0.002169	2.12	32.99	29.10	0.35
Reach-1	10.2*	80.00	97.32	99.28	98.52	99.35	0.001943	2.15	37.13	29.36	0.34
Reach-1	10.2*	90.00	97.32	99.40	98.59	99.48	0.001818	2.20	40.84	29.59	0.33
Reach-1	10.2*	100.00	97.32	99.52	98.65	99.60	0.001732	2.26	44.33	29.81	0.33
Reach-1	10.2*	200.00	97.32	100.37	99.13	100.49	0.001541	2.80	81.54	98.77	0.33
Reach-1	10.2*	500.00	97.32	101.36	100.17	101.51	0.001578	3.62	281.15	300.99	0.35
Reach-1	10.2*	750.00	97.32	101.82	101.07	101.97	0.001581	3.95	439.41	393.31	0.36
Reach-1	10.2*	1000.00	97.32	102.12	101.40	102.27	0.001614	4.20	557.84	400.25	0.37
Reach-1	10.2*	1500.00	97.32	102.61	101.92	102.77	0.001624	4.55	757.19	400.25	0.38
Reach-1	10	10.00	97.58	98.03	98.03	98.14	0.028270	2.63	3.80	16.95	0.98
Reach-1	10	20.00	97.58	98.16	98.16	98.32	0.027208	3.17	6.31	20.67	1.01
Reach-1	10	30.00	97.58	98.32	98.27	98.46	0.016743	3.03	9.90	24.10	0.83
Reach-1	10	40.00	97.58	98.56	98.35	98.66	0.006918	2.50	15.99	26.68	0.57
Reach-1	10	50.00	97.58	98.74	98.42	98.83	0.004669	2.39	20.92	27.71	0.48
Reach-1	10	60.00	97.58	98.90	98.49	98.99	0.003607	2.36	25.38	28.00	0.44

Reach-1	10	70.00	97.58	99.07	98.55	99.15	0.002821	2.32	30.17	28.31	0.40
Reach-1	10	80.00	97.58	99.22	98.61	99.30	0.002416	2.32	34.43	28.58	0.37
Reach-1	10	90.00	97.58	99.35	98.67	99.44	0.002206	2.36	38.17	28.82	0.36
Reach-1	10	100.00	97.58	99.47	98.72	99.56	0.002068	2.40	41.64	29.04	0.35
Reach-1	10	200.00	97.58	100.32	99.16	100.45	0.001759	2.94	77.26	94.89	0.35
Reach-1	10	500.00	97.58	101.32	100.40	101.48	0.001730	3.74	273.54	297.67	0.37
Reach-1	10	750.00	97.58	101.78	101.08	101.94	0.001693	4.04	431.92	390.94	0.37
Reach-1	10	1000.00	97.58	102.08	101.41	102.23	0.001703	4.27	551.66	400.00	0.38
Reach-1	10	1500.00	97.58	102.58	101.91	102.73	0.001689	4.60	751.66	400.00	0.38

Design Channel: Bankfull Discharge = 150 cfs; slope = 0.0026 ft/ft

Profile Output Table - Standard Table 1
HEC-RAS Plan: q150s26i River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 661
Plans = 1
Profiles = 15

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	20	10.00	100.40	100.96	100.86	101.01	0.010660	1.87	5.34	19.11	0.62
Reach-1	20	20.00	100.40	101.13	101.00	101.20	0.009661	2.18	9.16	24.13	0.62
Reach-1	20	30.00	100.40	101.28	101.12	101.36	0.007616	2.34	12.81	25.38	0.58
Reach-1	20	40.00	100.40	101.41	101.19	101.50	0.006343	2.47	16.18	25.64	0.55
Reach-1	20	50.00	100.40	101.53	101.26	101.64	0.005551	2.58	19.36	25.89	0.53
Reach-1	20	60.00	100.40	101.65	101.33	101.76	0.005046	2.69	22.34	26.11	0.51
Reach-1	20	70.00	100.40	101.76	101.39	101.88	0.004681	2.78	25.18	26.33	0.50
Reach-1	20	80.00	100.40	101.86	101.44	101.99	0.004420	2.87	27.88	26.53	0.49
Reach-1	20	90.00	100.40	101.95	101.50	102.09	0.004227	2.96	30.45	26.72	0.49
Reach-1	20	100.00	100.40	102.05	101.55	102.19	0.004078	3.04	32.91	26.90	0.48
Reach-1	20	200.00	100.40	102.78	102.02	103.00	0.003490	3.73	56.76	65.49	0.48
Reach-1	20	500.00	100.40	103.76	103.36	104.01	0.003045	4.59	217.05	263.24	0.48
Reach-1	20	750.00	100.40	104.19	103.81	104.43	0.002925	4.94	347.83	349.76	0.48
Reach-1	20	1000.00	100.40	104.51	104.10	104.73	0.002766	5.11	471.10	398.00	0.47
Reach-1	20	1500.00	100.40	104.95	104.54	105.17	0.002728	5.48	646.25	398.00	0.48
Reach-1	19.8*	10.00	100.15	100.70	100.62	100.77	0.013944	2.22	4.51	15.30	0.72
Reach-1	19.8*	20.00	100.15	100.92	100.78	101.01	0.009326	2.41	8.30	18.31	0.63
Reach-1	19.8*	30.00	100.15	101.12	100.90	101.21	0.007531	2.46	12.18	22.11	0.58
Reach-1	19.8*	40.00	100.15	101.28	101.01	101.38	0.006215	2.48	16.15	25.15	0.54
Reach-1	19.8*	50.00	100.15	101.43	101.10	101.53	0.005169	2.51	19.95	26.52	0.51
Reach-1	19.8*	60.00	100.15	101.56	101.19	101.66	0.004447	2.56	23.41	26.77	0.48
Reach-1	19.8*	70.00	100.15	101.68	101.26	101.79	0.004028	2.63	26.58	26.99	0.47
Reach-1	19.8*	80.00	100.15	101.79	101.32	101.90	0.003765	2.71	29.52	27.20	0.46
Reach-1	19.8*	90.00	100.15	101.89	101.38	102.01	0.003586	2.79	32.28	27.40	0.45
Reach-1	19.8*	100.00	100.15	101.98	101.44	102.11	0.003456	2.87	34.90	27.58	0.45
Reach-1	19.8*	200.00	100.15	102.74	101.89	102.93	0.003007	3.54	59.72	66.43	0.45
Reach-1	19.8*	500.00	100.15	103.71	103.24	103.94	0.002823	4.48	219.18	262.72	0.46
Reach-1	19.8*	750.00	100.15	104.13	103.73	104.37	0.002793	4.88	347.96	348.14	0.47
Reach-1	19.8*	1000.00	100.15	104.45	104.02	104.68	0.002701	5.10	469.14	398.33	0.47
Reach-1	19.8*	1500.00	100.15	104.89	104.48	105.11	0.002670	5.47	645.77	398.33	0.48
Reach-1	19.6*	10.00	99.90	100.59	100.36	100.63	0.003772	1.49	6.69	15.31	0.40
Reach-1	19.6*	20.00	99.90	100.84	100.52	100.89	0.003667	1.87	10.68	16.98	0.42
Reach-1	19.6*	30.00	99.90	101.03	100.66	101.10	0.003883	2.14	14.01	18.93	0.44
Reach-1	19.6*	40.00	99.90	101.19	100.76	101.28	0.004060	2.30	17.40	21.85	0.45
Reach-1	19.6*	50.00	99.90	101.35	100.86	101.43	0.004004	2.39	20.93	24.53	0.46
Reach-1	19.6*	60.00	99.90	101.48	100.94	101.58	0.003817	2.45	24.47	26.59	0.45
Reach-1	19.6*	70.00	99.90	101.61	101.04	101.71	0.003536	2.51	27.90	27.59	0.44
Reach-1	19.6*	80.00	99.90	101.72	101.13	101.83	0.003274	2.57	31.07	27.81	0.43

Reach-1	19.6*	90.00	99.90	101.83	101.20	101.94	0.003109	2.65	34.01	28.02	0.42
Reach-1	19.6*	100.00	99.90	101.93	101.28	102.04	0.002996	2.72	36.77	28.21	0.42
Reach-1	19.6*	200.00	99.90	102.69	101.78	102.87	0.002649	3.38	62.69	68.50	0.42
Reach-1	19.6*	500.00	99.90	103.66	103.11	103.88	0.002621	4.36	223.06	264.18	0.45
Reach-1	19.6*	750.00	99.90	104.07	103.64	104.31	0.002654	4.79	350.87	348.81	0.46
Reach-1	19.6*	1000.00	99.90	104.39	103.95	104.62	0.002608	5.04	470.86	398.67	0.46
Reach-1	19.6*	1500.00	99.90	104.84	104.42	105.06	0.002595	5.42	648.23	398.67	0.47
Reach-1	19.4*	10.00	99.65	100.57	100.09	100.59	0.001033	1.00	10.04	15.83	0.22
Reach-1	19.4*	20.00	99.65	100.81	100.26	100.84	0.001527	1.43	13.96	17.02	0.28
Reach-1	19.4*	30.00	99.65	100.99	100.39	101.04	0.001835	1.75	17.13	17.62	0.31
Reach-1	19.4*	40.00	99.65	101.15	100.51	101.21	0.002249	2.00	20.02	19.66	0.35
Reach-1	19.4*	50.00	99.65	101.29	100.61	101.37	0.002557	2.17	23.04	22.02	0.37
Reach-1	19.4*	60.00	99.65	101.43	100.71	101.51	0.002744	2.30	26.14	24.22	0.39
Reach-1	19.4*	70.00	99.65	101.55	100.79	101.64	0.002845	2.39	29.30	26.27	0.40
Reach-1	19.4*	80.00	99.65	101.67	100.87	101.76	0.002848	2.47	32.45	27.75	0.40
Reach-1	19.4*	90.00	99.65	101.78	100.95	101.88	0.002783	2.54	35.49	28.57	0.40
Reach-1	19.4*	100.00	99.65	101.88	101.02	101.98	0.002682	2.61	38.38	28.79	0.40
Reach-1	19.4*	200.00	99.65	102.65	101.67	102.82	0.002390	3.24	65.89	72.98	0.40
Reach-1	19.4*	500.00	99.65	103.62	102.97	103.83	0.002421	4.22	229.74	267.23	0.43
Reach-1	19.4*	750.00	99.65	104.03	103.55	104.25	0.002505	4.68	356.97	350.32	0.45
Reach-1	19.4*	1000.00	99.65	104.34	103.87	104.56	0.002494	4.95	476.02	399.00	0.45
Reach-1	19.4*	1500.00	99.65	104.79	104.35	105.01	0.002508	5.35	653.32	399.00	0.46
Reach-1	19.2*	10.00	99.39	100.56	99.81	100.57	0.000387	0.73	13.68	16.25	0.14
Reach-1	19.2*	20.00	99.39	100.80	99.99	100.82	0.000729	1.14	17.58	17.15	0.20
Reach-1	19.2*	30.00	99.39	100.98	100.13	101.01	0.000996	1.45	20.69	17.62	0.24
Reach-1	19.2*	40.00	99.39	101.13	100.25	101.17	0.001229	1.71	23.40	18.13	0.27
Reach-1	19.2*	50.00	99.39	101.27	100.36	101.32	0.001558	1.92	26.04	20.29	0.30
Reach-1	19.2*	60.00	99.39	101.39	100.46	101.46	0.001821	2.09	28.77	22.29	0.32
Reach-1	19.2*	70.00	99.39	101.51	100.55	101.59	0.002018	2.22	31.57	24.10	0.34
Reach-1	19.2*	80.00	99.39	101.63	100.64	101.71	0.002168	2.33	34.39	25.81	0.36
Reach-1	19.2*	90.00	99.39	101.73	100.71	101.82	0.002284	2.42	37.21	27.40	0.37
Reach-1	19.2*	100.00	99.39	101.83	100.78	101.93	0.002345	2.50	40.03	28.65	0.37
Reach-1	19.2*	200.00	99.39	102.62	101.48	102.77	0.002191	3.12	68.77	76.34	0.38
Reach-1	19.2*	500.00	99.39	103.58	102.83	103.78	0.002271	4.10	235.40	270.49	0.41
Reach-1	19.2*	750.00	99.39	103.98	103.47	104.20	0.002391	4.57	362.31	352.76	0.43
Reach-1	19.2*	1000.00	99.39	104.30	103.79	104.51	0.002399	4.85	481.00	399.33	0.44
Reach-1	19.2*	1500.00	99.39	104.74	104.29	104.95	0.002436	5.27	658.07	399.33	0.45
Reach-1	19.*	10.00	99.14	100.56	99.54	100.57	0.000189	0.58	17.19	16.54	0.10
Reach-1	19.*	20.00	99.14	100.79	99.73	100.80	0.000411	0.95	21.07	17.27	0.15
Reach-1	19.*	30.00	99.14	100.97	99.87	100.99	0.000611	1.24	24.15	17.68	0.19
Reach-1	19.*	40.00	99.14	101.12	99.99	101.15	0.000792	1.49	26.81	18.03	0.22
Reach-1	19.*	50.00	99.14	101.25	100.11	101.29	0.000990	1.71	29.25	18.93	0.24
Reach-1	19.*	60.00	99.14	101.37	100.21	101.43	0.001226	1.89	31.69	20.69	0.27
Reach-1	19.*	70.00	99.14	101.49	100.31	101.55	0.001433	2.05	34.18	22.35	0.29
Reach-1	19.*	80.00	99.14	101.60	100.40	101.67	0.001612	2.18	36.70	23.91	0.31
Reach-1	19.*	90.00	99.14	101.70	100.48	101.78	0.001767	2.29	39.22	25.37	0.33
Reach-1	19.*	100.00	99.14	101.80	100.56	101.89	0.001897	2.39	41.77	26.77	0.34
Reach-1	19.*	200.00	99.14	102.58	101.19	102.72	0.002070	3.03	71.23	79.85	0.37
Reach-1	19.*	500.00	99.14	103.54	102.72	103.73	0.002160	3.99	241.18	274.19	0.40
Reach-1	19.*	750.00	99.14	103.94	103.40	104.15	0.002303	4.47	368.08	355.74	0.42
Reach-1	19.*	1000.00	99.14	104.25	103.72	104.46	0.002318	4.75	486.83	399.67	0.43
Reach-1	19.*	1500.00	99.14	104.69	104.23	104.90	0.002375	5.18	663.40	399.67	0.45
Reach-1	18.8	10.00	98.89	100.56	99.27	100.56	0.000106	0.48	20.72	16.82	0.08
Reach-1	18.8	20.00	98.89	100.79	99.46	100.80	0.000253	0.81	24.60	17.37	0.12
Reach-1	18.8	30.00	98.89	100.96	99.60	100.98	0.000400	1.08	27.66	17.72	0.15

Reach-1	18.8	40.00	98.89	101.11	99.74	101.13	0.000540	1.32	30.28	18.02	0.18
Reach-1	18.8	50.00	98.89	101.24	99.85	101.28	0.000673	1.53	32.67	18.29	0.20
Reach-1	18.8	60.00	98.89	101.36	99.96	101.40	0.000837	1.72	34.90	19.33	0.23
Reach-1	18.8	70.00	98.89	101.47	100.06	101.53	0.001019	1.88	37.15	20.86	0.25
Reach-1	18.8	80.00	98.89	101.58	100.15	101.64	0.001189	2.03	39.43	22.29	0.27
Reach-1	18.8	90.00	98.89	101.68	100.24	101.75	0.001346	2.16	41.70	23.63	0.29
Reach-1	18.8	100.00	98.89	101.77	100.32	101.85	0.001489	2.27	43.99	24.92	0.30
Reach-1	18.8	200.00	98.89	102.54	100.98	102.68	0.001995	2.96	73.45	83.37	0.36
Reach-1	18.8	500.00	98.89	103.50	102.60	103.68	0.002076	3.89	246.68	277.51	0.39
Reach-1	18.8	750.00	98.89	103.90	103.33	104.10	0.002236	4.38	373.40	358.14	0.42
Reach-1	18.8	1000.00	98.89	104.21	103.65	104.41	0.002258	4.66	491.94	400.00	0.42
Reach-1	18.8	1500.00	98.89	104.65	104.17	104.85	0.002332	5.09	667.93	400.00	0.44
Reach-1	18.6*	10.00	99.14	100.56	99.55	100.56	0.000183	0.57	17.49	16.94	0.10
Reach-1	18.6*	20.00	99.14	100.78	99.72	100.79	0.000401	0.94	21.30	17.49	0.15
Reach-1	18.6*	30.00	99.14	100.94	99.87	100.97	0.000607	1.24	24.28	17.91	0.19
Reach-1	18.6*	40.00	99.14	101.09	99.99	101.12	0.000834	1.49	26.86	18.97	0.22
Reach-1	18.6*	50.00	99.14	101.21	100.10	101.26	0.001094	1.70	29.37	20.86	0.25
Reach-1	18.6*	60.00	99.14	101.33	100.20	101.38	0.001331	1.88	31.88	22.58	0.28
Reach-1	18.6*	70.00	99.14	101.44	100.30	101.50	0.001535	2.03	34.40	24.16	0.30
Reach-1	18.6*	80.00	99.14	101.54	100.39	101.61	0.001710	2.17	36.95	25.65	0.32
Reach-1	18.6*	90.00	99.14	101.63	100.47	101.72	0.001860	2.28	39.49	27.06	0.33
Reach-1	18.6*	100.00	99.14	101.73	100.54	101.82	0.001978	2.38	42.06	28.34	0.34
Reach-1	18.6*	200.00	99.14	102.50	101.22	102.64	0.002019	3.03	72.18	83.14	0.37
Reach-1	18.6*	500.00	99.14	103.45	102.64	103.64	0.002136	3.99	243.08	275.91	0.40
Reach-1	18.6*	750.00	99.14	103.85	103.31	104.05	0.002296	4.49	369.07	356.59	0.42
Reach-1	18.6*	1000.00	99.14	104.16	103.62	104.36	0.002312	4.77	487.60	399.50	0.43
Reach-1	18.6*	1500.00	99.14	104.59	104.13	104.81	0.002382	5.21	662.89	399.50	0.45
Reach-1	18.4*	10.00	99.39	100.55	99.83	100.56	0.000382	0.72	13.97	17.03	0.14
Reach-1	18.4*	20.00	99.39	100.76	100.00	100.78	0.000745	1.13	17.64	17.71	0.20
Reach-1	18.4*	30.00	99.39	100.92	100.13	100.95	0.001178	1.45	20.65	20.15	0.25
Reach-1	18.4*	40.00	99.39	101.05	100.25	101.10	0.001561	1.70	23.50	22.33	0.29
Reach-1	18.4*	50.00	99.39	101.17	100.35	101.23	0.001878	1.90	26.29	24.29	0.32
Reach-1	18.4*	60.00	99.39	101.28	100.45	101.35	0.002128	2.06	29.07	26.10	0.34
Reach-1	18.4*	70.00	99.39	101.39	100.53	101.46	0.002281	2.19	31.89	27.51	0.36
Reach-1	18.4*	80.00	99.39	101.49	100.61	101.57	0.002360	2.30	34.71	28.51	0.37
Reach-1	18.4*	90.00	99.39	101.58	100.68	101.67	0.002352	2.40	37.43	28.71	0.37
Reach-1	18.4*	100.00	99.39	101.67	100.75	101.77	0.002342	2.50	40.07	28.91	0.37
Reach-1	18.4*	200.00	99.39	102.44	101.41	102.60	0.002182	3.15	69.85	83.12	0.38
Reach-1	18.4*	500.00	99.39	103.39	102.72	103.59	0.002258	4.11	239.45	274.43	0.41
Reach-1	18.4*	750.00	99.39	103.79	103.29	104.01	0.002389	4.59	365.97	355.44	0.44
Reach-1	18.4*	1000.00	99.39	104.10	103.60	104.32	0.002382	4.85	485.18	399.00	0.44
Reach-1	18.4*	1500.00	99.39	104.54	104.09	104.76	0.002436	5.28	660.39	399.00	0.45
Reach-1	18.2*	10.00	99.63	100.53	100.10	100.54	0.001142	0.99	10.12	17.54	0.23
Reach-1	18.2*	20.00	99.63	100.72	100.26	100.75	0.002045	1.44	13.90	21.19	0.31
Reach-1	18.2*	30.00	99.63	100.87	100.39	100.92	0.002659	1.74	17.20	23.88	0.36
Reach-1	18.2*	40.00	99.63	100.99	100.48	101.05	0.003022	1.97	20.32	25.88	0.39
Reach-1	18.2*	50.00	99.63	101.11	100.59	101.18	0.003153	2.14	23.35	27.03	0.41
Reach-1	18.2*	60.00	99.63	101.22	100.68	101.30	0.003112	2.28	26.27	27.24	0.41
Reach-1	18.2*	70.00	99.63	101.32	100.77	101.41	0.003056	2.41	29.09	27.44	0.41
Reach-1	18.2*	80.00	99.63	101.42	100.84	101.52	0.002999	2.51	31.82	27.63	0.41
Reach-1	18.2*	90.00	99.63	101.51	100.91	101.62	0.002948	2.61	34.46	27.81	0.41
Reach-1	18.2*	100.00	99.63	101.60	100.97	101.72	0.002902	2.70	37.01	27.99	0.41
Reach-1	18.2*	200.00	99.63	102.37	101.44	102.55	0.002561	3.35	65.13	78.51	0.41
Reach-1	18.2*	500.00	99.63	103.32	102.78	103.54	0.002545	4.31	230.08	270.13	0.44
Reach-1	18.2*	750.00	99.63	103.73	103.29	103.96	0.002593	4.74	358.49	353.52	0.45
Reach-1	18.2*	1000.00	99.63	104.05	103.59	104.27	0.002525	4.97	479.76	398.50	0.45

Reach-1	18.2*	1500.00	99.63	104.49	104.05	104.70	0.002552	5.38	654.34	398.50	0.47
Reach-1	18	10.00	99.88	100.42	100.34	100.48	0.011991	1.96	5.11	18.72	0.66
Reach-1	18	20.00	99.88	100.57	100.48	100.66	0.013005	2.41	8.30	23.63	0.72
Reach-1	18	30.00	99.88	100.72	100.60	100.82	0.009892	2.54	11.82	25.29	0.65
Reach-1	18	40.00	99.88	100.85	100.67	100.96	0.007889	2.64	15.13	25.56	0.61
Reach-1	18	50.00	99.88	100.97	100.74	101.09	0.006751	2.74	18.22	25.80	0.58
Reach-1	18	60.00	99.88	101.08	100.81	101.21	0.005969	2.83	21.20	26.03	0.55
Reach-1	18	70.00	99.88	101.19	100.87	101.32	0.005411	2.91	24.07	26.24	0.54
Reach-1	18	80.00	99.88	101.30	100.92	101.44	0.005004	2.98	26.81	26.45	0.52
Reach-1	18	90.00	99.88	101.40	100.98	101.54	0.004704	3.06	29.44	26.65	0.51
Reach-1	18	100.00	99.88	101.49	101.03	101.64	0.004472	3.13	31.97	26.83	0.51
Reach-1	18	200.00	99.88	102.27	101.49	102.49	0.003440	3.72	57.27	67.05	0.47
Reach-1	18	500.00	99.88	103.23	102.84	103.48	0.003109	4.63	214.40	261.19	0.48
Reach-1	18	750.00	99.88	103.66	103.29	103.90	0.002960	4.96	345.69	348.52	0.48
Reach-1	18	1000.00	99.88	103.99	103.58	104.21	0.002782	5.12	469.99	398.00	0.47
Reach-1	18	1500.00	99.88	104.43	104.02	104.65	0.002738	5.49	645.41	398.00	0.48
Reach-1	17.8*	10.00	99.63	100.14	100.09	100.22	0.014620	2.19	4.56	16.33	0.73
Reach-1	17.8*	20.00	99.63	100.37	100.23	100.46	0.008519	2.32	8.63	18.87	0.60
Reach-1	17.8*	30.00	99.63	100.56	100.34	100.65	0.007042	2.41	12.45	22.28	0.57
Reach-1	17.8*	40.00	99.63	100.72	100.44	100.82	0.005889	2.45	16.35	24.97	0.53
Reach-1	17.8*	50.00	99.63	100.87	100.53	100.97	0.004860	2.49	20.05	25.72	0.50
Reach-1	17.8*	60.00	99.63	101.00	100.61	101.10	0.004266	2.56	23.42	26.05	0.48
Reach-1	17.8*	70.00	99.63	101.12	100.69	101.23	0.003905	2.64	26.54	26.35	0.46
Reach-1	17.8*	80.00	99.63	101.23	100.75	101.34	0.003662	2.71	29.48	26.63	0.45
Reach-1	17.8*	90.00	99.63	101.33	100.81	101.45	0.003493	2.79	32.25	26.90	0.45
Reach-1	17.8*	100.00	99.63	101.43	100.86	101.56	0.003367	2.86	34.90	27.15	0.45
Reach-1	17.8*	200.00	99.63	102.23	101.33	102.42	0.002786	3.46	61.50	69.47	0.43
Reach-1	17.8*	500.00	99.63	103.18	102.70	103.42	0.002797	4.49	217.70	260.99	0.46
Reach-1	17.8*	750.00	99.63	103.60	103.19	103.84	0.002774	4.89	346.40	346.79	0.47
Reach-1	17.8*	1000.00	99.63	103.92	103.48	104.15	0.002687	5.12	467.89	398.33	0.47
Reach-1	17.8*	1500.00	99.63	104.37	103.96	104.59	0.002662	5.49	644.59	398.33	0.48
Reach-1	17.6*	10.00	99.38	100.06	99.81	100.09	0.003061	1.36	7.36	16.66	0.36
Reach-1	17.6*	20.00	99.38	100.30	99.96	100.35	0.003054	1.71	11.67	18.54	0.38
Reach-1	17.6*	30.00	99.38	100.49	100.08	100.55	0.003121	1.97	15.22	19.87	0.40
Reach-1	17.6*	40.00	99.38	100.65	100.19	100.72	0.003310	2.14	18.65	22.40	0.41
Reach-1	17.6*	50.00	99.38	100.80	100.28	100.88	0.003308	2.25	22.19	24.74	0.42
Reach-1	17.6*	60.00	99.38	100.94	100.36	101.02	0.003122	2.34	25.67	25.90	0.41
Reach-1	17.6*	70.00	99.38	101.06	100.44	101.15	0.002931	2.42	28.92	26.31	0.41
Reach-1	17.6*	80.00	99.38	101.18	100.52	101.27	0.002810	2.50	31.95	26.69	0.40
Reach-1	17.6*	90.00	99.38	101.28	100.60	101.39	0.002733	2.59	34.80	27.04	0.40
Reach-1	17.6*	100.00	99.38	101.38	100.67	101.49	0.002677	2.67	37.52	27.37	0.40
Reach-1	17.6*	200.00	99.38	102.19	101.18	102.36	0.002371	3.27	65.42	72.96	0.40
Reach-1	17.6*	500.00	99.38	103.13	102.54	103.36	0.002548	4.35	222.70	262.99	0.44
Reach-1	17.6*	750.00	99.38	103.55	103.11	103.78	0.002603	4.80	350.18	347.72	0.46
Reach-1	17.6*	1000.00	99.38	103.87	103.41	104.10	0.002572	5.06	470.10	398.67	0.46
Reach-1	17.6*	1500.00	99.38	104.31	103.90	104.54	0.002574	5.45	647.15	398.67	0.47
Reach-1	17.4*	10.00	99.13	100.04	99.54	100.06	0.000829	0.91	11.01	16.94	0.20
Reach-1	17.4*	20.00	99.13	100.28	99.70	100.31	0.001259	1.32	15.20	18.30	0.25
Reach-1	17.4*	30.00	99.13	100.46	99.83	100.50	0.001530	1.61	18.59	19.00	0.29
Reach-1	17.4*	40.00	99.13	100.62	99.94	100.67	0.001816	1.85	21.63	20.45	0.32
Reach-1	17.4*	50.00	99.13	100.76	100.04	100.82	0.002071	2.02	24.73	22.60	0.34
Reach-1	17.4*	60.00	99.13	100.90	100.13	100.97	0.002234	2.15	27.90	24.60	0.36
Reach-1	17.4*	70.00	99.13	101.02	100.21	101.10	0.002296	2.25	31.07	26.07	0.36
Reach-1	17.4*	80.00	99.13	101.14	100.29	101.22	0.002261	2.35	34.11	26.57	0.36
Reach-1	17.4*	90.00	99.13	101.24	100.36	101.33	0.002246	2.43	36.98	27.03	0.37

Reach-1	17.4*	100.00	99.13	101.34	100.43	101.44	0.002238	2.52	39.72	27.46	0.37
Reach-1	17.4*	200.00	99.13	102.16	101.05	102.31	0.002107	3.13	68.93	76.85	0.38
Reach-1	17.4*	500.00	99.13	103.09	102.38	103.31	0.002365	4.22	227.80	265.21	0.43
Reach-1	17.4*	750.00	99.13	103.50	103.02	103.73	0.002475	4.70	354.09	348.64	0.45
Reach-1	17.4*	1000.00	99.13	103.81	103.34	104.04	0.002487	4.99	472.39	399.00	0.45
Reach-1	17.4*	1500.00	99.13	104.26	103.84	104.48	0.002509	5.40	649.61	399.00	0.46
Reach-1	17.2*	10.00	98.87	100.04	99.27	100.04	0.000336	0.69	14.51	16.99	0.13
Reach-1	17.2*	20.00	98.87	100.27	99.44	100.29	0.000642	1.08	18.59	18.02	0.19
Reach-1	17.2*	30.00	98.87	100.45	99.57	100.48	0.000882	1.37	21.85	18.56	0.22
Reach-1	17.2*	40.00	98.87	100.60	99.69	100.64	0.001082	1.62	24.69	19.02	0.25
Reach-1	17.2*	50.00	98.87	100.74	99.79	100.79	0.001340	1.82	27.45	20.83	0.28
Reach-1	17.2*	60.00	98.87	100.87	99.89	100.93	0.001556	1.98	30.26	22.64	0.30
Reach-1	17.2*	70.00	98.87	100.99	99.98	101.06	0.001727	2.11	33.10	24.33	0.32
Reach-1	17.2*	80.00	98.87	101.10	100.07	101.18	0.001862	2.22	35.96	25.93	0.33
Reach-1	17.2*	90.00	98.87	101.21	100.14	101.29	0.001913	2.32	38.76	26.70	0.34
Reach-1	17.2*	100.00	98.87	101.31	100.21	101.40	0.001947	2.41	41.46	27.30	0.34
Reach-1	17.2*	200.00	98.87	102.13	100.87	102.27	0.001943	3.02	72.46	82.89	0.36
Reach-1	17.2*	500.00	98.87	103.05	102.24	103.26	0.002202	4.08	235.87	270.01	0.41
Reach-1	17.2*	750.00	98.87	103.46	102.94	103.68	0.002340	4.57	362.39	352.18	0.43
Reach-1	17.2*	1000.00	98.87	103.77	103.24	103.99	0.002368	4.86	480.38	399.33	0.44
Reach-1	17.2*	1500.00	98.87	104.21	103.77	104.43	0.002419	5.29	656.97	399.33	0.45
Reach-1	17.*	10.00	98.62	100.03	99.01	100.04	0.000175	0.56	17.74	16.95	0.10
Reach-1	17.*	20.00	98.62	100.26	99.19	100.27	0.000382	0.92	21.72	17.71	0.15
Reach-1	17.*	30.00	98.62	100.44	99.32	100.46	0.000570	1.21	24.86	18.13	0.18
Reach-1	17.*	40.00	98.62	100.59	99.45	100.62	0.000739	1.45	27.58	18.49	0.21
Reach-1	17.*	50.00	98.62	100.72	99.56	100.76	0.000908	1.66	30.11	19.17	0.23
Reach-1	17.*	60.00	98.62	100.85	99.66	100.90	0.001122	1.84	32.61	20.90	0.26
Reach-1	17.*	70.00	98.62	100.96	99.75	101.02	0.001311	1.99	35.15	22.52	0.28
Reach-1	17.*	80.00	98.62	101.07	99.84	101.14	0.001475	2.12	37.71	24.04	0.30
Reach-1	17.*	90.00	98.62	101.18	99.93	101.25	0.001618	2.24	40.27	25.47	0.31
Reach-1	17.*	100.00	98.62	101.27	100.01	101.36	0.001729	2.33	42.83	26.69	0.32
Reach-1	17.*	200.00	98.62	102.10	100.63	102.23	0.001866	2.94	74.98	87.11	0.35
Reach-1	17.*	500.00	98.62	103.02	102.13	103.21	0.002116	3.97	241.58	273.92	0.40
Reach-1	17.*	750.00	98.62	103.42	102.86	103.63	0.002269	4.47	368.29	355.42	0.42
Reach-1	17.*	1000.00	98.62	103.73	103.19	103.94	0.002299	4.76	486.40	399.67	0.43
Reach-1	17.*	1500.00	98.62	104.17	103.71	104.38	0.002367	5.20	662.43	399.67	0.45
Reach-1	16.8	10.00	98.37	100.03	98.75	100.04	0.000108	0.49	20.58	16.78	0.08
Reach-1	16.8	20.00	98.37	100.26	98.94	100.27	0.000258	0.82	24.44	17.35	0.12
Reach-1	16.8	30.00	98.37	100.43	99.08	100.45	0.000408	1.09	27.47	17.70	0.15
Reach-1	16.8	40.00	98.37	100.58	99.22	100.60	0.000551	1.33	30.09	18.00	0.18
Reach-1	16.8	50.00	98.37	100.71	99.33	100.75	0.000684	1.54	32.50	18.27	0.20
Reach-1	16.8	60.00	98.37	100.83	99.44	100.88	0.000843	1.73	34.75	19.22	0.23
Reach-1	16.8	70.00	98.37	100.94	99.54	101.00	0.001026	1.89	37.01	20.76	0.25
Reach-1	16.8	80.00	98.37	101.05	99.63	101.11	0.001197	2.04	39.29	22.20	0.27
Reach-1	16.8	90.00	98.37	101.15	99.72	101.22	0.001354	2.16	41.58	23.56	0.29
Reach-1	16.8	100.00	98.37	101.25	99.80	101.33	0.001497	2.28	43.88	24.86	0.30
Reach-1	16.8	200.00	98.37	102.06	100.46	102.19	0.001868	2.90	76.67	90.85	0.35
Reach-1	16.8	500.00	98.37	102.98	102.08	103.16	0.002083	3.89	246.16	277.13	0.39
Reach-1	16.8	750.00	98.37	103.38	102.81	103.58	0.002241	4.38	372.96	357.89	0.42
Reach-1	16.8	1000.00	98.37	103.69	103.14	103.89	0.002268	4.66	491.03	400.00	0.42
Reach-1	16.8	1500.00	98.37	104.13	103.65	104.33	0.002344	5.10	666.60	400.00	0.44
Reach-1	16.6*	10.00	98.62	100.03	99.01	100.03	0.000165	0.55	18.29	17.59	0.09
Reach-1	16.6*	20.00	98.62	100.25	99.18	100.26	0.000362	0.90	22.25	18.18	0.14
Reach-1	16.6*	30.00	98.62	100.42	99.32	100.44	0.000549	1.18	25.34	18.64	0.18
Reach-1	16.6*	40.00	98.62	100.56	99.44	100.59	0.000741	1.43	28.03	19.46	0.21

Reach-1	16.6*	50.00	98.62	100.69	99.55	100.73	0.000966	1.63	30.66	21.27	0.24
Reach-1	16.6*	60.00	98.62	100.81	99.65	100.86	0.001169	1.80	33.27	22.93	0.26
Reach-1	16.6*	70.00	98.62	100.92	99.74	100.98	0.001347	1.95	35.87	24.47	0.28
Reach-1	16.6*	80.00	98.62	101.02	99.82	101.09	0.001502	2.08	38.49	25.93	0.30
Reach-1	16.6*	90.00	98.62	101.12	99.90	101.19	0.001600	2.19	41.09	26.81	0.31
Reach-1	16.6*	100.00	98.62	101.21	99.98	101.29	0.001672	2.29	43.63	27.46	0.32
Reach-1	16.6*	200.00	98.62	102.02	100.62	102.15	0.001763	2.90	77.27	92.61	0.35
Reach-1	16.6*	500.00	98.62	102.93	102.03	103.12	0.002069	3.96	244.33	276.11	0.40
Reach-1	16.6*	750.00	98.62	103.33	102.78	103.53	0.002245	4.48	369.88	356.49	0.42
Reach-1	16.6*	1000.00	98.62	103.63	103.10	103.84	0.002283	4.77	487.32	399.50	0.43
Reach-1	16.6*	1500.00	98.62	104.07	103.62	104.28	0.002372	5.23	661.47	399.50	0.45
Reach-1	16.4*	10.00	98.86	100.02	99.28	100.03	0.000312	0.66	15.25	18.31	0.13
Reach-1	16.4*	20.00	98.86	100.24	99.44	100.25	0.000612	1.04	19.25	19.15	0.18
Reach-1	16.4*	30.00	98.86	100.40	99.56	100.42	0.000937	1.33	22.49	21.14	0.23
Reach-1	16.4*	40.00	98.86	100.53	99.68	100.57	0.001233	1.57	25.51	23.13	0.26
Reach-1	16.4*	50.00	98.86	100.66	99.77	100.71	0.001473	1.75	28.50	24.95	0.29
Reach-1	16.4*	60.00	98.86	100.77	99.87	100.83	0.001626	1.91	31.45	26.12	0.31
Reach-1	16.4*	70.00	98.86	100.88	99.95	100.95	0.001705	2.04	34.28	26.59	0.32
Reach-1	16.4*	80.00	98.86	100.98	100.02	101.05	0.001770	2.16	37.01	27.04	0.33
Reach-1	16.4*	90.00	98.86	101.08	100.10	101.16	0.001823	2.27	39.64	27.46	0.33
Reach-1	16.4*	100.00	98.86	101.17	100.16	101.26	0.001868	2.37	42.20	27.86	0.34
Reach-1	16.4*	200.00	98.86	101.98	100.78	102.12	0.001820	2.98	76.44	95.01	0.35
Reach-1	16.4*	500.00	98.86	102.88	102.12	103.07	0.002133	4.05	243.04	276.42	0.41
Reach-1	16.4*	750.00	98.86	103.28	102.76	103.49	0.002297	4.56	368.95	356.84	0.43
Reach-1	16.4*	1000.00	98.86	103.58	103.07	103.79	0.002313	4.84	487.29	399.00	0.44
Reach-1	16.4*	1500.00	98.86	104.02	103.57	104.23	0.002401	5.30	660.63	399.00	0.45
Reach-1	16.2*	10.00	99.11	100.01	99.56	100.02	0.000889	0.89	11.27	19.08	0.20
Reach-1	16.2*	20.00	99.11	100.21	99.70	100.23	0.001540	1.30	15.41	22.22	0.27
Reach-1	16.2*	30.00	99.11	100.36	99.82	100.40	0.001997	1.58	18.96	24.70	0.32
Reach-1	16.2*	40.00	99.11	100.49	99.92	100.54	0.002201	1.80	22.26	25.74	0.34
Reach-1	16.2*	50.00	99.11	100.61	100.01	100.67	0.002277	1.97	25.37	26.09	0.35
Reach-1	16.2*	60.00	99.11	100.72	100.10	100.79	0.002326	2.12	28.30	26.41	0.36
Reach-1	16.2*	70.00	99.11	100.83	100.18	100.90	0.002354	2.25	31.11	26.72	0.37
Reach-1	16.2*	80.00	99.11	100.93	100.26	101.01	0.002375	2.37	33.79	27.01	0.37
Reach-1	16.2*	90.00	99.11	101.02	100.33	101.12	0.002390	2.47	36.38	27.29	0.38
Reach-1	16.2*	100.00	99.11	101.11	100.39	101.21	0.002403	2.57	38.88	27.55	0.38
Reach-1	16.2*	200.00	99.11	101.92	100.86	102.08	0.002128	3.17	72.03	92.53	0.38
Reach-1	16.2*	500.00	99.11	102.81	102.22	103.02	0.002415	4.25	233.84	272.20	0.43
Reach-1	16.2*	750.00	99.11	103.22	102.76	103.44	0.002513	4.72	360.82	354.29	0.45
Reach-1	16.2*	1000.00	99.11	103.53	103.06	103.75	0.002477	4.97	480.68	398.50	0.45
Reach-1	16.2*	1500.00	99.11	103.96	103.53	104.18	0.002534	5.40	653.62	398.50	0.47
Reach-1	16	10.00	99.36	99.92	99.82	99.97	0.010661	1.87	5.34	19.11	0.62
Reach-1	16	20.00	99.36	100.09	99.96	100.16	0.009660	2.18	9.16	24.13	0.62
Reach-1	16	30.00	99.36	100.24	100.08	100.32	0.007618	2.34	12.01	25.38	0.58
Reach-1	16	40.00	99.36	100.37	100.15	100.46	0.006346	2.47	16.18	25.64	0.55
Reach-1	16	50.00	99.36	100.49	100.22	100.60	0.005556	2.58	19.36	25.89	0.53
Reach-1	16	60.00	99.36	100.61	100.29	100.72	0.005054	2.69	22.33	26.11	0.51
Reach-1	16	70.00	99.36	100.71	100.35	100.84	0.004693	2.78	25.16	26.33	0.50
Reach-1	16	80.00	99.36	100.82	100.40	100.94	0.004434	2.87	27.85	26.53	0.49
Reach-1	16	90.00	99.36	100.91	100.46	101.05	0.004238	2.96	30.42	26.72	0.49
Reach-1	16	100.00	99.36	101.01	100.51	101.15	0.004087	3.04	32.89	26.90	0.48
Reach-1	16	200.00	99.36	101.83	100.98	102.02	0.002953	3.54	63.30	83.31	0.44
Reach-1	16	500.00	99.36	102.72	102.32	102.97	0.003043	4.59	217.14	263.31	0.48
Reach-1	16	750.00	99.36	103.15	102.77	103.39	0.002923	4.94	347.94	349.83	0.48
Reach-1	16	1000.00	99.36	103.47	103.06	103.69	0.002764	5.11	471.19	398.00	0.47
Reach-1	16	1500.00	99.36	103.91	103.50	104.13	0.002733	5.48	645.81	398.00	0.48

Reach-1	15.8*	10.00	99.11	99.66	99.58	99.73	0.013962	2.22	4.51	15.30	0.72
Reach-1	15.8*	20.00	99.11	99.88	99.74	99.97	0.009337	2.41	8.29	18.30	0.63
Reach-1	15.8*	30.00	99.11	100.08	99.87	100.17	0.007540	2.46	12.17	22.11	0.59
Reach-1	15.8*	40.00	99.11	100.24	99.97	100.34	0.006221	2.48	16.14	25.14	0.54
Reach-1	15.8*	50.00	99.11	100.39	100.06	100.49	0.005176	2.51	19.94	26.52	0.51
Reach-1	15.8*	60.00	99.11	100.52	100.15	100.62	0.004458	2.57	23.39	26.76	0.48
Reach-1	15.8*	70.00	99.11	100.64	100.22	100.74	0.004042	2.64	26.55	26.99	0.47
Reach-1	15.8*	80.00	99.11	100.74	100.28	100.86	0.003779	2.71	29.48	27.20	0.46
Reach-1	15.8*	90.00	99.11	100.85	100.34	100.97	0.003597	2.79	32.24	27.39	0.45
Reach-1	15.8*	100.00	99.11	100.94	100.40	101.07	0.003464	2.87	34.87	27.58	0.45
Reach-1	15.8*	200.00	99.11	101.79	100.85	101.97	0.002513	3.34	67.15	86.17	0.41
Reach-1	15.8*	500.00	99.11	102.67	102.20	102.90	0.002821	4.48	219.28	262.80	0.46
Reach-1	15.8*	750.00	99.11	103.09	102.69	103.33	0.002790	4.88	348.10	348.22	0.47
Reach-1	15.8*	1000.00	99.11	103.41	102.98	103.64	0.002699	5.10	469.27	398.33	0.47
Reach-1	15.8*	1500.00	99.11	103.85	103.44	104.07	0.002676	5.47	645.25	398.33	0.48
Reach-1	15.6*	10.00	98.86	99.55	99.32	99.59	0.003783	1.50	6.68	15.31	0.40
Reach-1	15.6*	20.00	98.86	99.80	99.48	99.85	0.003673	1.87	10.67	16.98	0.42
Reach-1	15.6*	30.00	98.86	99.99	99.62	100.06	0.003887	2.14	14.00	18.92	0.44
Reach-1	15.6*	40.00	98.86	100.15	99.72	100.24	0.004063	2.30	17.40	21.84	0.45
Reach-1	15.6*	50.00	98.86	100.31	99.81	100.39	0.004009	2.39	20.92	24.52	0.46
Reach-1	15.6*	60.00	98.86	100.44	99.90	100.54	0.003828	2.45	24.45	26.58	0.45
Reach-1	15.6*	70.00	98.86	100.57	100.00	100.67	0.003551	2.51	27.86	27.59	0.44
Reach-1	15.6*	80.00	98.86	100.68	100.08	100.79	0.003289	2.58	31.03	27.81	0.43
Reach-1	15.6*	90.00	98.86	100.79	100.16	100.90	0.003121	2.65	33.97	28.02	0.42
Reach-1	15.6*	100.00	98.86	100.89	100.24	101.00	0.003005	2.72	36.74	28.21	0.42
Reach-1	15.6*	200.00	98.86	101.76	100.74	101.91	0.002186	3.18	71.13	90.11	0.38
Reach-1	15.6*	500.00	98.86	102.62	102.07	102.85	0.002618	4.36	223.17	264.27	0.45
Reach-1	15.6*	750.00	98.86	103.03	102.60	103.27	0.002652	4.79	351.03	348.91	0.46
Reach-1	15.6*	1000.00	98.86	103.35	102.90	103.58	0.002606	5.04	471.02	398.67	0.46
Reach-1	15.6*	1500.00	98.86	103.79	103.38	104.02	0.002601	5.43	647.61	398.67	0.47
Reach-1	15.4*	10.00	98.60	99.53	99.05	99.55	0.001016	0.99	10.09	15.83	0.22
Reach-1	15.4*	20.00	98.60	99.77	99.21	99.80	0.001509	1.43	14.02	17.02	0.28
Reach-1	15.4*	30.00	98.60	99.95	99.35	100.00	0.001817	1.75	17.18	17.62	0.31
Reach-1	15.4*	40.00	98.60	100.11	99.47	100.17	0.002230	1.99	20.07	19.66	0.35
Reach-1	15.4*	50.00	98.60	100.25	99.57	100.33	0.002539	2.17	23.09	22.02	0.37
Reach-1	15.4*	60.00	98.60	100.39	99.66	100.47	0.002730	2.29	26.18	24.21	0.39
Reach-1	15.4*	70.00	98.60	100.51	99.75	100.60	0.002837	2.39	29.32	26.25	0.40
Reach-1	15.4*	80.00	98.60	100.63	99.83	100.72	0.002843	2.46	32.46	27.74	0.40
Reach-1	15.4*	90.00	98.60	100.74	99.91	100.84	0.002779	2.53	35.51	28.57	0.40
Reach-1	15.4*	100.00	98.60	100.84	99.97	100.94	0.002677	2.60	38.41	28.78	0.40
Reach-1	15.4*	200.00	98.60	101.73	100.63	101.87	0.001938	3.03	75.74	96.32	0.36
Reach-1	15.4*	500.00	98.60	102.58	101.93	102.79	0.002415	4.22	229.90	267.31	0.43
Reach-1	15.4*	750.00	98.60	102.99	102.51	103.21	0.002501	4.67	357.13	350.39	0.45
Reach-1	15.4*	1000.00	98.60	103.30	102.83	103.52	0.002492	4.95	476.11	399.00	0.45
Reach-1	15.4*	1500.00	98.60	103.74	103.32	103.96	0.002514	5.35	652.60	399.00	0.46
Reach-1	15.2*	10.00	98.35	99.52	98.77	99.53	0.000387	0.73	13.69	16.25	0.14
Reach-1	15.2*	20.00	98.35	99.76	98.95	99.78	0.000729	1.14	17.58	17.15	0.20
Reach-1	15.2*	30.00	98.35	99.94	99.09	99.97	0.000996	1.45	20.70	17.63	0.24
Reach-1	15.2*	40.00	98.35	100.09	99.21	100.13	0.001228	1.71	23.40	18.13	0.27
Reach-1	15.2*	50.00	98.35	100.23	99.32	100.28	0.001558	1.92	26.04	20.29	0.30
Reach-1	15.2*	60.00	98.35	100.35	99.42	100.42	0.001823	2.09	28.76	22.28	0.32
Reach-1	15.2*	70.00	98.35	100.47	99.51	100.55	0.002023	2.22	31.53	24.08	0.34
Reach-1	15.2*	80.00	98.35	100.59	99.60	100.67	0.002174	2.33	34.35	25.78	0.36
Reach-1	15.2*	90.00	98.35	100.69	99.67	100.78	0.002290	2.42	37.16	27.37	0.37
Reach-1	15.2*	100.00	98.35	100.79	99.74	100.89	0.002350	2.50	39.99	28.63	0.37

Reach-1	15.2*	200.00	98.35	101.70	100.44	101.83	0.001757	2.91	79.82	101.45	0.35
Reach-1	15.2*	500.00	98.35	102.54	101.79	102.74	0.002269	4.10	235.56	270.61	0.41
Reach-1	15.2*	750.00	98.35	102.94	102.43	103.16	0.002389	4.57	362.52	352.88	0.43
Reach-1	15.2*	1000.00	98.35	103.26	102.75	103.47	0.002397	4.85	481.20	399.33	0.44
Reach-1	15.2*	1500.00	98.35	103.70	103.25	103.91	0.002444	5.27	657.31	399.33	0.45
Reach-1	15.*	10.00	98.10	99.52	98.50	99.53	0.000189	0.58	17.19	16.54	0.10
Reach-1	15.*	20.00	98.10	99.75	98.69	99.76	0.000411	0.95	21.07	17.27	0.15
Reach-1	15.*	30.00	98.10	99.93	98.83	99.95	0.000611	1.24	24.15	17.68	0.19
Reach-1	15.*	40.00	98.10	100.08	98.95	100.11	0.000792	1.49	26.81	18.03	0.22
Reach-1	15.*	50.00	98.10	100.21	99.07	100.25	0.000990	1.71	29.25	18.93	0.24
Reach-1	15.*	60.00	98.10	100.33	99.17	100.39	0.001227	1.89	31.67	20.68	0.27
Reach-1	15.*	70.00	98.10	100.45	99.27	100.51	0.001436	2.05	34.15	22.33	0.29
Reach-1	15.*	80.00	98.10	100.56	99.36	100.63	0.001616	2.18	36.66	23.88	0.31
Reach-1	15.*	90.00	98.10	100.66	99.44	100.74	0.001771	2.30	39.18	25.35	0.33
Reach-1	15.*	100.00	98.10	100.76	99.52	100.84	0.001900	2.40	41.74	26.75	0.34
Reach-1	15.*	200.00	98.10	101.67	100.15	101.79	0.001634	2.81	83.66	106.81	0.33
Reach-1	15.*	500.00	98.10	102.50	101.68	102.69	0.002157	3.99	241.36	274.32	0.40
Reach-1	15.*	750.00	98.10	102.90	102.36	103.11	0.002300	4.47	368.32	355.87	0.42
Reach-1	15.*	1000.00	98.10	103.21	102.68	103.42	0.002315	4.75	487.07	399.67	0.43
Reach-1	15.*	1500.00	98.10	103.65	103.19	103.86	0.002383	5.19	662.56	399.67	0.45
Reach-1	14.8	10.00	97.85	99.52	98.23	99.52	0.000106	0.48	20.72	16.82	0.08
Reach-1	14.8	20.00	97.85	99.75	98.42	99.76	0.000253	0.81	24.60	17.37	0.12
Reach-1	14.8	30.00	97.85	99.92	98.56	99.94	0.000399	1.08	27.66	17.72	0.15
Reach-1	14.8	40.00	97.85	100.07	98.70	100.09	0.000540	1.32	30.29	18.02	0.18
Reach-1	14.8	50.00	97.85	100.20	98.81	100.24	0.000673	1.53	32.67	18.29	0.20
Reach-1	14.8	60.00	97.85	100.32	98.92	100.36	0.000837	1.72	34.89	19.32	0.23
Reach-1	14.8	70.00	97.85	100.43	99.02	100.48	0.001020	1.89	37.12	20.84	0.25
Reach-1	14.8	80.00	97.85	100.53	99.11	100.60	0.001191	2.03	39.39	22.27	0.27
Reach-1	14.8	90.00	97.85	100.63	99.20	100.71	0.001349	2.16	41.66	23.61	0.29
Reach-1	14.8	100.00	97.85	100.73	99.28	100.81	0.001491	2.27	43.96	24.90	0.30
Reach-1	14.8	200.00	97.85	101.65	99.94	101.76	0.001546	2.72	87.38	112.18	0.32
Reach-1	14.8	500.00	97.85	102.46	101.56	102.64	0.002073	3.88	246.88	277.66	0.39
Reach-1	14.8	750.00	97.85	102.86	102.29	103.06	0.002233	4.37	373.67	358.29	0.41
Reach-1	14.8	1000.00	97.85	103.17	102.62	103.37	0.002255	4.65	492.20	400.00	0.42
Reach-1	14.8	1500.00	97.85	103.61	103.13	103.81	0.002340	5.10	667.01	400.00	0.44
Reach-1	14.6*	10.00	98.10	99.52	98.51	99.52	0.000183	0.57	17.49	16.94	0.10
Reach-1	14.6*	20.00	98.10	99.74	98.68	99.75	0.000401	0.94	21.30	17.49	0.15
Reach-1	14.6*	30.00	98.10	99.91	98.83	99.93	0.000606	1.24	24.28	17.91	0.19
Reach-1	14.6*	40.00	98.10	100.05	98.95	100.08	0.000833	1.49	26.86	18.97	0.22
Reach-1	14.6*	50.00	98.10	100.17	99.06	100.22	0.001095	1.70	29.37	20.86	0.25
Reach-1	14.6*	60.00	98.10	100.29	99.17	100.34	0.001332	1.88	31.86	22.57	0.28
Reach-1	14.6*	70.00	98.10	100.39	99.26	100.46	0.001538	2.04	34.37	24.14	0.30
Reach-1	14.6*	80.00	98.10	100.50	99.35	100.57	0.001715	2.17	36.90	25.63	0.32
Reach-1	14.6*	90.00	98.10	100.59	99.43	100.67	0.001866	2.28	39.44	27.04	0.33
Reach-1	14.6*	100.00	98.10	100.69	99.50	100.77	0.001983	2.38	42.02	28.32	0.34
Reach-1	14.6*	200.00	98.10	101.61	100.18	101.73	0.001532	2.76	87.50	114.54	0.32
Reach-1	14.6*	500.00	98.10	102.41	101.60	102.60	0.002132	3.99	243.31	276.09	0.40
Reach-1	14.6*	750.00	98.10	102.81	102.27	103.01	0.002292	4.48	369.38	356.76	0.42
Reach-1	14.6*	1000.00	98.10	103.12	102.58	103.32	0.002308	4.76	487.92	399.50	0.43
Reach-1	14.6*	1500.00	98.10	103.55	103.09	103.76	0.002392	5.21	661.81	399.50	0.45
Reach-1	14.4*	10.00	98.35	99.51	98.79	99.52	0.000384	0.72	13.94	17.01	0.14
Reach-1	14.4*	20.00	98.35	99.72	98.96	99.74	0.000750	1.14	17.61	17.71	0.20
Reach-1	14.4*	30.00	98.35	99.88	99.09	99.91	0.001184	1.45	20.62	20.15	0.25
Reach-1	14.4*	40.00	98.35	100.01	99.21	100.06	0.001569	1.70	23.46	22.33	0.29
Reach-1	14.4*	50.00	98.35	100.13	99.31	100.19	0.001887	1.90	26.25	24.28	0.32

Reach-1	14.4*	60.00	98.35	100.24	99.41	100.31	0.002141	2.07	29.01	26.08	0.35
Reach-1	14.4*	70.00	98.35	100.35	99.49	100.42	0.002300	2.20	31.80	27.48	0.36
Reach-1	14.4*	80.00	98.35	100.45	99.57	100.53	0.002383	2.31	34.60	28.49	0.37
Reach-1	14.4*	90.00	98.35	100.54	99.64	100.63	0.002372	2.41	37.33	28.70	0.37
Reach-1	14.4*	100.00	98.35	100.63	99.71	100.73	0.002359	2.50	39.97	28.89	0.37
Reach-1	14.4*	200.00	98.35	101.57	100.37	101.70	0.001613	2.85	86.13	115.93	0.33
Reach-1	14.4*	500.00	98.35	102.35	101.67	102.55	0.002296	4.14	236.79	273.02	0.42
Reach-1	14.4*	750.00	98.35	102.75	102.26	102.97	0.002427	4.62	362.85	354.49	0.44
Reach-1	14.4*	1000.00	98.35	103.06	102.57	103.28	0.002418	4.89	481.98	399.00	0.44
Reach-1	14.4*	1500.00	98.35	103.50	103.06	103.71	0.002481	5.32	655.81	399.00	0.46
Reach-1	14.2*	10.00	98.59	99.49	99.06	99.50	0.001142	0.99	10.12	17.54	0.23
Reach-1	14.2*	20.00	98.59	99.68	99.22	99.71	0.002045	1.44	13.90	21.19	0.31
Reach-1	14.2*	30.00	98.59	99.83	99.35	99.88	0.002659	1.74	17.20	23.88	0.36
Reach-1	14.2*	40.00	98.59	99.95	99.44	100.01	0.003023	1.97	20.32	25.88	0.39
Reach-1	14.2*	50.00	98.59	100.07	99.55	100.14	0.003158	2.14	23.34	27.03	0.41
Reach-1	14.2*	60.00	98.59	100.17	99.64	100.26	0.003125	2.29	26.23	27.24	0.41
Reach-1	14.2*	70.00	98.59	100.28	99.73	100.37	0.003078	2.41	29.02	27.43	0.41
Reach-1	14.2*	80.00	98.59	100.37	99.80	100.47	0.003023	2.52	31.74	27.62	0.41
Reach-1	14.2*	90.00	98.59	100.47	99.87	100.58	0.002969	2.62	34.38	27.81	0.41
Reach-1	14.2*	100.00	98.59	100.56	99.93	100.68	0.002916	2.71	36.95	27.98	0.42
Reach-1	14.2*	200.00	98.59	101.53	100.40	101.66	0.001785	2.98	84.22	117.89	0.35
Reach-1	14.2*	500.00	98.59	102.28	101.74	102.50	0.002549	4.31	229.90	270.00	0.44
Reach-1	14.2*	750.00	98.59	102.69	102.25	102.92	0.002594	4.74	358.40	353.47	0.45
Reach-1	14.2*	1000.00	98.59	103.01	102.55	103.23	0.002527	4.97	479.63	398.50	0.45
Reach-1	14.2*	1500.00	98.59	103.45	103.01	103.66	0.002556	5.38	654.05	398.50	0.47
Reach-1	14	10.00	98.84	99.38	99.30	99.44	0.011994	1.96	5.11	18.72	0.66
Reach-1	14	20.00	98.84	99.53	99.44	99.62	0.013007	2.41	8.30	23.63	0.72
Reach-1	14	30.00	98.84	99.68	99.56	99.78	0.009892	2.54	11.82	25.29	0.65
Reach-1	14	40.00	98.84	99.81	99.63	99.92	0.007895	2.64	15.13	25.56	0.61
Reach-1	14	50.00	98.84	99.93	99.70	100.05	0.006777	2.75	18.20	25.80	0.58
Reach-1	14	60.00	98.84	100.04	99.77	100.17	0.006026	2.84	21.14	26.02	0.55
Reach-1	14	70.00	98.84	100.15	99.83	100.28	0.005489	2.92	23.96	26.23	0.54
Reach-1	14	80.00	98.84	100.25	99.88	100.39	0.005077	3.00	26.69	26.44	0.53
Reach-1	14	90.00	98.84	100.35	99.94	100.50	0.004759	3.07	29.33	26.64	0.52
Reach-1	14	100.00	98.84	100.45	99.99	100.60	0.004508	3.14	31.88	26.83	0.51
Reach-1	14	200.00	98.84	101.47	100.45	101.62	0.002183	3.20	78.70	114.84	0.38
Reach-1	14	500.00	98.84	102.19	101.80	102.44	0.003114	4.63	214.17	261.02	0.48
Reach-1	14	750.00	98.84	102.62	102.25	102.86	0.002962	4.96	345.57	348.45	0.48
Reach-1	14	1000.00	98.84	102.95	102.54	103.17	0.002784	5.12	469.83	398.00	0.47
Reach-1	14	1500.00	98.84	103.39	102.98	103.61	0.002744	5.49	644.89	398.00	0.48
Reach-1	13.8*	10.00	98.59	99.10	99.05	99.18	0.014612	2.19	4.57	16.33	0.73
Reach-1	13.8*	20.00	98.59	99.33	99.19	99.42	0.008513	2.32	8.63	18.87	0.60
Reach-1	13.8*	30.00	98.59	99.52	99.30	99.61	0.007042	2.41	12.45	22.28	0.57
Reach-1	13.8*	40.00	98.59	99.68	99.40	99.78	0.005899	2.45	16.34	24.97	0.53
Reach-1	13.8*	50.00	98.59	99.83	99.49	99.92	0.004890	2.50	20.01	25.71	0.50
Reach-1	13.8*	60.00	98.59	99.96	99.57	100.06	0.004321	2.57	23.32	26.04	0.48
Reach-1	13.8*	70.00	98.59	100.07	99.65	100.18	0.003973	2.65	26.39	26.34	0.47
Reach-1	13.8*	80.00	98.59	100.18	99.71	100.30	0.003724	2.73	29.32	26.62	0.46
Reach-1	13.8*	90.00	98.59	100.29	99.77	100.41	0.003540	2.80	32.12	26.88	0.45
Reach-1	13.8*	100.00	98.59	100.39	99.82	100.52	0.003397	2.87	34.80	27.14	0.45
Reach-1	13.8*	200.00	98.59	101.45	100.29	101.58	0.001743	2.97	85.68	120.93	0.35
Reach-1	13.8*	500.00	98.59	102.14	101.66	102.38	0.002803	4.50	217.44	260.78	0.46
Reach-1	13.8*	750.00	98.59	102.56	102.15	102.80	0.002776	4.89	346.24	346.70	0.47
Reach-1	13.8*	1000.00	98.59	102.88	102.44	103.11	0.002690	5.12	467.67	398.33	0.47
Reach-1	13.8*	1500.00	98.59	103.32	102.92	103.55	0.002669	5.50	643.96	398.33	0.48

Reach-1	13.6*	10.00	98.34	99.02	98.77	99.05	0.003058	1.36	7.37	16.66	0.36
Reach-1	13.6*	20.00	98.34	99.26	98.92	99.31	0.003051	1.71	11.68	18.54	0.38
Reach-1	13.6*	30.00	98.34	99.45	99.04	99.51	0.003122	1.97	15.22	19.87	0.40
Reach-1	13.6*	40.00	98.34	99.61	99.15	99.68	0.003315	2.15	18.64	22.40	0.41
Reach-1	13.6*	50.00	98.34	99.76	99.24	99.84	0.003327	2.26	22.14	24.71	0.42
Reach-1	13.6*	60.00	98.34	99.89	99.32	99.98	0.003167	2.35	25.56	25.89	0.42
Reach-1	13.6*	70.00	98.34	100.02	99.40	100.11	0.002987	2.44	28.74	26.29	0.41
Reach-1	13.6*	80.00	98.34	100.13	99.48	100.23	0.002862	2.52	31.76	26.66	0.41
Reach-1	13.6*	90.00	98.34	100.24	99.57	100.34	0.002771	2.60	34.64	27.02	0.40
Reach-1	13.6*	100.00	98.34	100.34	99.63	100.45	0.002702	2.67	37.40	27.35	0.40
Reach-1	13.6*	200.00	98.34	101.43	100.14	101.54	0.001458	2.78	92.56	127.83	0.32
Reach-1	13.6*	500.00	98.34	102.09	101.50	102.32	0.002554	4.35	222.40	262.76	0.44
Reach-1	13.6*	750.00	98.34	102.51	102.07	102.74	0.002606	4.80	350.00	347.61	0.46
Reach-1	13.6*	1000.00	98.34	102.83	102.37	103.06	0.002576	5.06	469.82	398.67	0.46
Reach-1	13.6*	1500.00	98.34	103.27	102.86	103.50	0.002582	5.46	646.41	398.67	0.47
Reach-1	13.4*	10.00	98.09	99.00	98.50	99.02	0.000839	0.91	10.96	16.93	0.20
Reach-1	13.4*	20.00	98.09	99.24	98.66	99.27	0.001271	1.32	15.16	18.30	0.26
Reach-1	13.4*	30.00	98.09	99.42	98.79	99.46	0.001543	1.62	18.55	19.00	0.29
Reach-1	13.4*	40.00	98.09	99.58	98.90	99.63	0.001831	1.85	21.57	20.43	0.32
Reach-1	13.4*	50.00	98.09	99.72	99.00	99.78	0.002093	2.03	24.64	22.56	0.34
Reach-1	13.4*	60.00	98.09	99.85	99.09	99.92	0.002271	2.16	27.73	24.52	0.36
Reach-1	13.4*	70.00	98.09	99.97	99.17	100.05	0.002353	2.27	30.83	26.03	0.37
Reach-1	13.4*	80.00	98.09	100.09	99.25	100.17	0.002314	2.36	33.86	26.53	0.37
Reach-1	13.4*	90.00	98.09	100.20	99.32	100.29	0.002287	2.45	36.75	27.00	0.37
Reach-1	13.4*	100.00	98.09	100.30	99.39	100.40	0.002268	2.53	39.54	27.44	0.37
Reach-1	13.4*	200.00	98.09	101.41	100.01	101.51	0.001271	2.64	99.13	134.80	0.30
Reach-1	13.4*	500.00	98.09	102.05	101.34	102.27	0.002374	4.23	227.38	264.92	0.43
Reach-1	13.4*	750.00	98.09	102.46	101.98	102.69	0.002480	4.70	353.81	348.51	0.45
Reach-1	13.4*	1000.00	98.09	102.77	102.30	103.00	0.002493	4.99	471.98	399.00	0.45
Reach-1	13.4*	1500.00	98.09	103.22	102.80	103.44	0.002519	5.41	648.73	399.00	0.46
Reach-1	13.2*	10.00	97.83	99.00	98.23	99.00	0.000336	0.69	14.51	16.98	0.13
Reach-1	13.2*	20.00	97.83	99.23	98.40	99.25	0.000642	1.08	18.58	18.02	0.19
Reach-1	13.2*	30.00	97.83	99.41	98.53	99.44	0.000883	1.37	21.84	18.56	0.22
Reach-1	13.2*	40.00	97.83	99.56	98.65	99.60	0.001084	1.62	24.68	19.02	0.25
Reach-1	13.2*	50.00	97.83	99.69	98.75	99.75	0.001345	1.82	27.40	20.80	0.28
Reach-1	13.2*	60.00	97.83	99.82	98.85	99.88	0.001571	1.99	30.13	22.56	0.30
Reach-1	13.2*	70.00	97.83	99.94	98.94	100.01	0.001752	2.13	32.90	24.22	0.32
Reach-1	13.2*	80.00	97.83	100.05	99.03	100.13	0.001889	2.24	35.74	25.80	0.34
Reach-1	13.2*	90.00	97.83	100.16	99.10	100.24	0.001940	2.33	38.57	26.66	0.34
Reach-1	13.2*	100.00	97.83	100.26	99.17	100.35	0.001966	2.42	41.32	27.27	0.35
Reach-1	13.2*	200.00	97.83	101.39	99.83	101.48	0.001136	2.52	106.67	143.86	0.28
Reach-1	13.2*	500.00	97.83	102.01	101.20	102.21	0.002208	4.08	235.46	269.70	0.41
Reach-1	13.2*	750.00	97.83	102.42	101.90	102.64	0.002343	4.57	362.13	352.03	0.43
Reach-1	13.2*	1000.00	97.83	102.73	102.20	102.95	0.002373	4.87	479.94	399.33	0.44
Reach-1	13.2*	1500.00	97.83	103.17	102.73	103.39	0.002429	5.30	656.02	399.33	0.45
Reach-1	13.*	10.00	97.58	98.99	97.97	99.00	0.000175	0.56	17.74	16.95	0.10
Reach-1	13.*	20.00	97.58	99.22	98.15	99.23	0.000382	0.92	21.71	17.71	0.15
Reach-1	13.*	30.00	97.58	99.40	98.28	99.42	0.000570	1.21	24.85	18.13	0.18
Reach-1	13.*	40.00	97.58	99.55	98.41	99.58	0.000741	1.45	27.57	18.49	0.21
Reach-1	13.*	50.00	97.58	99.68	98.52	99.72	0.000911	1.66	30.06	19.14	0.23
Reach-1	13.*	60.00	97.58	99.80	98.62	99.85	0.001130	1.85	32.49	20.82	0.26
Reach-1	13.*	70.00	97.58	99.91	98.71	99.98	0.001326	2.00	34.95	22.39	0.28
Reach-1	13.*	80.00	97.58	100.02	98.80	100.09	0.001494	2.13	37.49	23.91	0.30
Reach-1	13.*	90.00	97.58	100.13	98.89	100.21	0.001635	2.25	40.07	25.37	0.31
Reach-1	13.*	100.00	97.58	100.23	98.97	100.31	0.001744	2.34	42.69	26.64	0.33
Reach-1	13.*	200.00	97.58	101.37	99.59	101.46	0.001055	2.42	112.93	151.49	0.27

Reach-1	13.*	500.00	97.58	101.98	101.09	102.17	0.002123	3.98	241.13	273.59	0.40
Reach-1	13.*	750.00	97.58	102.38	101.82	102.59	0.002273	4.47	368.00	355.26	0.42
Reach-1	13.*	1000.00	97.58	102.69	102.15	102.90	0.002304	4.76	485.90	399.67	0.43
Reach-1	13.*	1500.00	97.58	103.13	102.67	103.34	0.002377	5.20	661.38	399.67	0.45
Reach-1	12.8	10.00	97.33	98.99	97.71	99.00	0.000108	0.49	20.58	16.78	0.08
Reach-1	12.8	20.00	97.33	99.22	97.90	99.23	0.000258	0.82	24.44	17.35	0.12
Reach-1	12.8	30.00	97.33	99.39	98.05	99.41	0.000408	1.09	27.47	17.70	0.15
Reach-1	12.8	40.00	97.33	99.54	98.18	99.56	0.000552	1.33	30.07	18.00	0.18
Reach-1	12.8	50.00	97.33	99.67	98.29	99.70	0.000687	1.54	32.45	18.27	0.20
Reach-1	12.8	60.00	97.33	99.79	98.40	99.83	0.000848	1.73	34.64	19.14	0.23
Reach-1	12.8	70.00	97.33	99.89	98.50	99.95	0.001036	1.90	36.82	20.64	0.25
Reach-1	12.8	80.00	97.33	100.00	98.59	100.07	0.001209	2.05	39.08	22.08	0.27
Reach-1	12.8	90.00	97.33	100.10	98.68	100.18	0.001366	2.17	41.39	23.46	0.29
Reach-1	12.8	100.00	97.33	100.20	98.76	100.28	0.001507	2.29	43.74	24.78	0.30
Reach-1	12.8	200.00	97.33	101.36	99.42	101.44	0.001012	2.35	118.61	158.79	0.26
Reach-1	12.8	500.00	97.33	101.94	101.04	102.12	0.002091	3.90	245.66	276.76	0.39
Reach-1	12.8	750.00	97.33	102.34	101.77	102.54	0.002245	4.38	372.63	357.70	0.42
Reach-1	12.8	1000.00	97.33	102.65	102.09	102.85	0.002274	4.67	490.47	400.00	0.42
Reach-1	12.8	1500.00	97.33	103.08	102.61	103.29	0.002355	5.11	665.44	400.00	0.44
Reach-1	12.6*	10.00	97.58	98.99	97.97	98.99	0.000165	0.55	18.29	17.59	0.09
Reach-1	12.6*	20.00	97.58	99.21	98.14	99.22	0.000362	0.90	22.24	18.18	0.14
Reach-1	12.6*	30.00	97.58	99.38	98.28	99.40	0.000549	1.18	25.34	18.63	0.18
Reach-1	12.6*	40.00	97.58	99.52	98.40	99.55	0.000742	1.43	28.01	19.45	0.21
Reach-1	12.6*	50.00	97.58	99.65	98.51	99.69	0.000969	1.63	30.60	21.23	0.24
Reach-1	12.6*	60.00	97.58	99.76	98.61	99.81	0.001179	1.81	33.12	22.84	0.27
Reach-1	12.6*	70.00	97.58	99.87	98.70	99.93	0.001367	1.96	35.64	24.34	0.29
Reach-1	12.6*	80.00	97.58	99.97	98.78	100.04	0.001524	2.09	38.23	25.79	0.30
Reach-1	12.6*	90.00	97.58	100.07	98.86	100.15	0.001625	2.20	40.86	26.75	0.31
Reach-1	12.6*	100.00	97.58	100.17	98.94	100.25	0.001690	2.30	43.46	27.42	0.32
Reach-1	12.6*	200.00	97.58	101.34	99.58	101.42	0.000932	2.33	122.82	164.40	0.26
Reach-1	12.6*	500.00	97.58	101.89	100.99	102.08	0.002077	3.97	243.74	275.67	0.40
Reach-1	12.6*	750.00	97.58	102.29	101.74	102.49	0.002250	4.48	369.51	356.28	0.42
Reach-1	12.6*	1000.00	97.58	102.59	102.06	102.80	0.002291	4.78	486.66	399.50	0.43
Reach-1	12.6*	1500.00	97.58	103.03	102.58	103.24	0.002385	5.24	660.11	399.50	0.45
Reach-1	12.4*	10.00	97.82	98.98	98.24	98.99	0.000309	0.65	15.29	18.31	0.13
Reach-1	12.4*	20.00	97.82	99.20	98.39	99.21	0.000608	1.04	19.29	19.13	0.18
Reach-1	12.4*	30.00	97.82	99.36	98.52	99.38	0.000929	1.33	22.50	21.04	0.23
Reach-1	12.4*	40.00	97.82	99.49	98.64	99.53	0.001230	1.57	25.50	23.07	0.26
Reach-1	12.4*	50.00	97.82	99.62	98.73	99.66	0.001479	1.76	28.44	24.89	0.29
Reach-1	12.4*	60.00	97.82	99.73	98.82	99.78	0.001652	1.92	31.28	26.09	0.31
Reach-1	12.4*	70.00	97.82	99.83	98.91	99.90	0.001745	2.06	34.02	26.54	0.32
Reach-1	12.4*	80.00	97.82	99.93	98.98	100.00	0.001810	2.18	36.73	26.98	0.33
Reach-1	12.4*	90.00	97.82	100.03	99.05	100.11	0.001857	2.28	39.40	27.40	0.34
Reach-1	12.4*	100.00	97.82	100.12	99.12	100.21	0.001891	2.38	42.02	27.81	0.34
Reach-1	12.4*	200.00	97.82	101.32	99.74	101.40	0.000921	2.36	125.51	169.80	0.26
Reach-1	12.4*	500.00	97.82	101.83	101.07	102.03	0.002185	4.09	238.93	273.55	0.41
Reach-1	12.4*	750.00	97.82	102.23	101.72	102.45	0.002350	4.60	364.03	354.35	0.43
Reach-1	12.4*	1000.00	97.82	102.54	102.04	102.75	0.002379	4.90	481.23	399.00	0.44
Reach-1	12.4*	1500.00	97.82	102.97	102.54	103.19	0.002463	5.36	654.03	399.00	0.46
Reach-1	12.2*	10.00	98.07	98.97	98.52	98.98	0.000890	0.89	11.27	19.08	0.20
Reach-1	12.2*	20.00	98.07	99.17	98.66	99.19	0.001540	1.30	15.41	22.22	0.27
Reach-1	12.2*	30.00	98.07	99.32	98.78	99.36	0.001998	1.58	18.96	24.70	0.32
Reach-1	12.2*	40.00	98.07	99.45	98.88	99.50	0.002209	1.80	22.24	25.74	0.34
Reach-1	12.2*	50.00	98.07	99.56	98.97	99.63	0.002302	1.98	25.28	26.08	0.35
Reach-1	12.2*	60.00	98.07	99.67	99.06	99.74	0.002380	2.14	28.09	26.39	0.36

Reach-1	12.2*	70.00	98.07	99.77	99.14	99.85	0.002432	2.27	30.79	26.69	0.37
Reach-1	12.2*	80.00	98.07	99.87	99.22	99.96	0.002450	2.39	33.46	26.98	0.38
Reach-1	12.2*	90.00	98.07	99.97	99.29	100.07	0.002450	2.49	36.09	27.26	0.38
Reach-1	12.2*	100.00	98.07	100.06	99.35	100.17	0.002443	2.59	38.67	27.53	0.38
Reach-1	12.2*	200.00	98.07	101.30	99.82	101.38	0.000976	2.41	127.69	176.36	0.27
Reach-1	12.2*	500.00	98.07	101.77	101.19	101.98	0.002439	4.27	232.47	271.18	0.43
Reach-1	12.2*	750.00	98.07	102.17	101.72	102.40	0.002527	4.73	359.73	353.67	0.45
Reach-1	12.2*	1000.00	98.07	102.49	102.02	102.70	0.002499	4.98	478.93	398.50	0.45
		1500.00	98.07	102.92	102.49	103.14	0.002550	5.42	652.11	398.50	0.47
Reach-1	12	10.00	98.32	98.88	98.78	98.93	0.010677	1.87	5.34	19.11	0.62
Reach-1	12	20.00	98.32	99.05	98.92	99.12	0.009659	2.18	9.16	24.13	0.62
Reach-1	12	30.00	98.32	99.20	99.04	99.28	0.007639	2.34	12.80	25.38	0.58
Reach-1	12	40.00	98.32	99.33	99.11	99.42	0.006409	2.48	16.13	25.64	0.55
Reach-1	12	50.00	98.32	99.45	99.18	99.55	0.005696	2.60	19.21	25.87	0.53
Reach-1	12	60.00	98.32	99.55	99.25	99.67	0.005306	2.73	21.99	26.09	0.52
Reach-1	12	70.00	98.32	99.66	99.31	99.78	0.004994	2.84	24.68	26.29	0.52
Reach-1	12	80.00	98.32	99.76	99.36	99.89	0.004687	2.92	27.37	26.49	0.51
Reach-1	12	90.00	98.32	99.86	99.42	100.00	0.004420	3.00	30.02	26.69	0.50
Reach-1	12	100.00	98.32	99.95	99.47	100.10	0.004199	3.07	32.61	26.88	0.49
Reach-1	12	200.00	98.32	101.27	99.94	101.36	0.001139	2.54	126.05	179.97	0.28
Reach-1	12	500.00	98.32	101.67	101.28	101.92	0.003081	4.62	215.53	262.07	0.48
Reach-1	12	750.00	98.32	102.10	101.73	102.34	0.002945	4.95	346.58	349.04	0.48
Reach-1	12	1000.00	98.32	102.43	102.02	102.65	0.002796	5.13	469.01	398.00	0.48
Reach-1	12	1500.00	98.32	102.86	102.46	103.09	0.002758	5.50	643.63	398.00	0.48
Reach-1	11.8*	10.00	98.07	98.61	98.54	98.69	0.014268	2.23	4.48	15.26	0.73
Reach-1	11.8*	20.00	98.07	98.84	98.70	98.93	0.009369	2.42	8.28	18.29	0.63
Reach-1	11.8*	30.00	98.07	99.03	98.83	99.13	0.007609	2.47	12.13	22.07	0.59
Reach-1	11.8*	40.00	98.07	99.20	98.93	99.29	0.006367	2.50	16.02	25.09	0.55
Reach-1	11.8*	50.00	98.07	99.34	99.02	99.44	0.005413	2.54	19.67	26.50	0.52
Reach-1	11.8*	60.00	98.07	99.46	99.11	99.57	0.004799	2.62	22.86	26.73	0.50
Reach-1	11.8*	70.00	98.07	99.57	99.18	99.68	0.004403	2.71	25.85	26.94	0.49
Reach-1	11.8*	80.00	98.07	99.68	99.24	99.80	0.004060	2.78	28.83	27.15	0.47
Reach-1	11.8*	90.00	98.07	99.79	99.30	99.91	0.003788	2.84	31.73	27.36	0.46
Reach-1	11.8*	100.00	98.07	99.89	99.36	100.02	0.003578	2.90	34.52	27.55	0.46
Reach-1	11.8*	200.00	98.07	101.26	99.81	101.33	0.000947	2.37	136.11	188.06	0.26
Reach-1	11.8*	500.00	98.07	101.62	101.16	101.86	0.002862	4.51	217.38	261.33	0.46
Reach-1	11.8*	750.00	98.07	102.04	101.65	102.28	0.002816	4.89	346.42	347.25	0.47
Reach-1	11.8*	1000.00	98.07	102.36	101.94	102.59	0.002741	5.13	466.33	398.33	0.47
		1500.00	98.07	102.80	102.40	103.03	0.002705	5.50	642.64	398.33	0.48
Reach-1	11.6*	10.00	97.82	98.51	98.28	98.54	0.003996	1.52	6.56	15.23	0.41
Reach-1	11.6*	20.00	97.82	98.76	98.44	98.81	0.003693	1.88	10.66	16.97	0.42
Reach-1	11.6*	30.00	97.82	98.94	98.58	99.02	0.003922	2.15	13.95	18.87	0.44
Reach-1	11.6*	40.00	97.82	99.11	98.68	99.19	0.004157	2.32	17.23	21.71	0.46
Reach-1	11.6*	50.00	97.82	99.25	98.78	99.34	0.004187	2.43	20.56	24.26	0.47
Reach-1	11.6*	60.00	97.82	99.38	98.86	99.47	0.004159	2.53	23.73	26.26	0.47
Reach-1	11.6*	70.00	97.82	99.49	98.96	99.60	0.003970	2.60	26.91	27.52	0.46
Reach-1	11.6*	80.00	97.82	99.61	99.05	99.72	0.003592	2.65	30.18	27.75	0.45
Reach-1	11.6*	90.00	97.82	99.72	99.12	99.84	0.003317	2.70	33.32	27.97	0.44
Reach-1	11.6*	100.00	97.82	99.83	99.20	99.95	0.003118	2.75	36.31	28.18	0.43
Reach-1	11.6*	200.00	97.82	101.25	99.70	101.31	0.000804	2.23	146.71	196.97	0.24
Reach-1	11.6*	500.00	97.82	101.57	101.03	101.80	0.002661	4.39	220.98	262.57	0.45
Reach-1	11.6*	750.00	97.82	101.99	101.56	102.22	0.002680	4.81	349.08	347.77	0.46
Reach-1	11.6*	1000.00	97.82	102.30	101.86	102.53	0.002657	5.08	467.22	398.67	0.47
		1500.00	97.82	102.75	102.34	102.97	0.002635	5.46	644.55	398.67	0.47
Reach-1	11.4*	10.00	97.57	98.48	98.01	98.50	0.001076	1.01	9.91	15.82	0.22

Reach-1	11.4*	20.00	97.57	98.73	98.18	98.76	0.001525	1.43	13.97	17.03	0.28
Reach-1	11.4*	30.00	97.57	98.91	98.31	98.96	0.001842	1.75	17.11	17.61	0.31
Reach-1	11.4*	40.00	97.57	99.06	98.43	99.12	0.002277	2.01	19.89	19.53	0.35
Reach-1	11.4*	50.00	97.57	99.20	98.53	99.27	0.002641	2.20	22.70	21.74	0.38
Reach-1	11.4*	60.00	97.57	99.32	98.63	99.40	0.002933	2.36	25.40	23.68	0.40
Reach-1	11.4*	70.00	97.57	99.43	98.71	99.53	0.003107	2.48	28.23	25.57	0.42
Reach-1	11.4*	80.00	97.57	99.55	98.79	99.65	0.003094	2.54	31.45	27.32	0.42
Reach-1	11.4*	90.00	97.57	99.67	98.87	99.77	0.002987	2.59	34.71	28.51	0.41
Reach-1	11.4*	100.00	97.57	99.78	98.94	99.89	0.002795	2.64	37.88	28.75	0.41
Reach-1	11.4*	200.00	97.57	101.24	99.59	101.30	0.000691	2.10	158.84	206.88	0.23
Reach-1	11.4*	500.00	97.57	101.53	100.90	101.74	0.002459	4.25	227.46	265.47	0.43
Reach-1	11.4*	750.00	97.57	101.94	101.47	102.17	0.002529	4.69	354.99	349.16	0.45
Reach-1	11.4*	1000.00	97.57	102.25	101.78	102.48	0.002547	4.99	471.76	399.00	0.46
Reach-1	11.4*	1500.00	97.57	102.70	102.27	102.92	0.002550	5.38	649.22	399.00	0.46
Reach-1	11.2*	10.00	97.31	98.47	97.73	98.48	0.000401	0.74	13.53	16.19	0.14
Reach-1	11.2*	20.00	97.31	98.72	97.91	98.74	0.000732	1.14	17.56	17.14	0.20
Reach-1	11.2*	30.00	97.31	98.89	98.05	98.93	0.001005	1.45	20.64	17.62	0.24
Reach-1	11.2*	40.00	97.31	99.04	98.17	99.08	0.001245	1.72	23.25	18.01	0.27
Reach-1	11.2*	50.00	97.31	99.17	98.28	99.23	0.001602	1.95	25.69	20.02	0.30
Reach-1	11.2*	60.00	97.31	99.28	98.38	99.35	0.001929	2.14	28.01	21.77	0.33
Reach-1	11.2*	70.00	97.31	99.39	98.47	99.47	0.002182	2.30	30.48	23.42	0.35
Reach-1	11.2*	80.00	97.31	99.51	98.56	99.60	0.002327	2.40	33.35	25.19	0.37
Reach-1	11.2*	90.00	97.31	99.62	98.63	99.72	0.002413	2.48	36.34	26.92	0.38
Reach-1	11.2*	100.00	97.31	99.73	98.70	99.83	0.002435	2.54	39.44	28.40	0.38
Reach-1	11.2*	200.00	97.31	101.23	99.40	101.28	0.000607	1.99	170.14	216.31	0.21
Reach-1	11.2*	500.00	97.31	101.49	100.76	101.69	0.002314	4.13	232.78	268.52	0.42
Reach-1	11.2*	750.00	97.31	101.90	101.39	102.12	0.002420	4.59	360.02	351.46	0.44
Reach-1	11.2*	1000.00	97.31	102.20	101.71	102.42	0.002460	4.90	475.98	399.33	0.45
Reach-1	11.2*	1500.00	97.31	102.65	102.21	102.87	0.002483	5.31	653.46	399.33	0.46
Reach-1	11.*	10.00	97.06	98.47	97.46	98.48	0.000195	0.59	17.02	16.49	0.10
Reach-1	11.*	20.00	97.06	98.71	97.65	98.72	0.000412	0.95	21.05	17.26	0.15
Reach-1	11.*	30.00	97.06	98.88	97.79	98.91	0.000615	1.25	24.09	17.67	0.19
Reach-1	11.*	40.00	97.06	99.03	97.91	99.06	0.000806	1.50	26.65	18.01	0.22
Reach-1	11.*	50.00	97.06	99.15	98.03	99.20	0.001011	1.73	28.91	18.67	0.24
Reach-1	11.*	60.00	97.06	99.26	98.13	99.32	0.001281	1.94	30.97	20.19	0.28
Reach-1	11.*	70.00	97.06	99.36	98.23	99.43	0.001525	2.11	33.15	21.68	0.30
Reach-1	11.*	80.00	97.06	99.47	98.32	99.55	0.001710	2.24	35.70	23.30	0.32
Reach-1	11.*	90.00	97.06	99.59	98.40	99.67	0.001852	2.34	38.39	24.89	0.33
Reach-1	11.*	100.00	97.06	99.69	98.48	99.79	0.001957	2.43	41.19	26.45	0.34
Reach-1	11.*	200.00	97.06	101.22	99.11	101.27	0.000544	1.90	181.53	225.89	0.20
Reach-1	11.*	500.00	97.06	101.45	100.64	101.64	0.002204	4.02	238.25	272.01	0.41
Reach-1	11.*	750.00	97.06	101.86	101.32	102.06	0.002333	4.49	365.51	354.27	0.43
Reach-1	11.*	1000.00	97.06	102.16	101.64	102.37	0.002384	4.81	481.07	399.67	0.44
Reach-1	11.*	1500.00	97.06	102.60	102.15	102.81	0.002425	5.22	658.30	399.67	0.45
Reach-1	10.8	10.00	96.81	98.47	97.19	98.47	0.000109	0.49	20.55	16.77	0.08
Reach-1	10.8	20.00	96.81	98.71	97.38	98.72	0.000254	0.81	24.58	17.37	0.12
Reach-1	10.8	30.00	96.81	98.88	97.52	98.90	0.000402	1.09	27.60	17.72	0.15
Reach-1	10.8	40.00	96.81	99.02	97.66	99.05	0.000549	1.33	30.13	18.01	0.18
Reach-1	10.8	50.00	96.81	99.14	97.77	99.18	0.000694	1.55	32.34	18.25	0.20
Reach-1	10.8	60.00	96.81	99.24	97.88	99.29	0.000865	1.75	34.22	18.85	0.23
Reach-1	10.8	70.00	96.81	99.34	97.98	99.40	0.001069	1.93	36.18	20.21	0.25
Reach-1	10.8	80.00	96.81	99.45	98.07	99.52	0.001246	2.08	38.47	21.70	0.28
Reach-1	10.8	90.00	96.81	99.56	98.16	99.64	0.001400	2.20	40.90	23.17	0.29
Reach-1	10.8	100.00	96.81	99.67	98.24	99.75	0.001529	2.30	43.43	24.61	0.31
Reach-1	10.8	200.00	96.81	101.21	98.90	101.26	0.000495	1.81	192.90	235.07	0.19
Reach-1	10.8	500.00	96.81	101.41	100.52	101.60	0.002123	3.92	243.43	275.13	0.40

Reach-1	10.8	750.00	96.81	101.81	101.25	102.01	0.002269	4.40	370.51	356.50	0.42
Reach-1	10.8	1000.00	96.81	102.11	101.57	102.32	0.002332	4.72	485.37	400.00	0.43
Reach-1	10.8	1500.00	96.81	102.56	102.09	102.76	0.002385	5.14	662.30	400.00	0.44
Reach-1	10.6*	10.00	97.06	98.47	97.47	98.47	0.000189	0.58	17.32	16.91	0.10
Reach-1	10.6*	20.00	97.06	98.70	97.64	98.71	0.000403	0.94	21.27	17.49	0.15
Reach-1	10.6*	30.00	97.06	98.86	97.79	98.89	0.000611	1.24	24.22	17.90	0.19
Reach-1	10.6*	40.00	97.06	99.00	97.91	99.03	0.000844	1.50	26.69	18.83	0.22
Reach-1	10.6*	50.00	97.06	99.11	98.02	99.16	0.001125	1.73	28.97	20.57	0.26
Reach-1	10.6*	60.00	97.06	99.21	98.12	99.27	0.001408	1.93	31.04	22.02	0.29
Reach-1	10.6*	70.00	97.06	99.31	98.22	99.37	0.001660	2.11	33.19	23.41	0.31
Reach-1	10.6*	80.00	97.06	99.41	98.31	99.49	0.001840	2.24	35.76	24.97	0.33
Reach-1	10.6*	90.00	97.06	99.52	98.39	99.60	0.001972	2.34	38.49	26.52	0.34
Reach-1	10.6*	100.00	97.06	99.62	98.46	99.71	0.002061	2.42	41.36	28.03	0.35
Reach-1	10.6*	200.00	97.06	101.21	99.14	101.25	0.000467	1.80	200.54	242.69	0.19
Reach-1	10.6*	500.00	97.06	101.36	100.56	101.55	0.002193	4.03	239.24	273.08	0.41
Reach-1	10.6*	750.00	97.06	101.76	101.23	101.97	0.002335	4.52	365.74	354.69	0.43
Reach-1	10.6*	1000.00	97.06	102.06	101.54	102.27	0.002402	4.84	479.80	399.50	0.44
Reach-1	10.6*	1500.00	97.06	102.50	102.05	102.71	0.002446	5.26	656.30	399.50	0.45
Reach-1	10.4*	10.00	97.31	98.46	97.75	98.47	0.000397	0.73	13.79	16.99	0.14
Reach-1	10.4*	20.00	97.31	98.68	97.92	98.70	0.000748	1.14	17.62	17.70	0.20
Reach-1	10.4*	30.00	97.31	98.83	98.05	98.87	0.001188	1.46	20.58	20.09	0.25
Reach-1	10.4*	40.00	97.31	98.96	98.17	99.01	0.001596	1.72	23.28	22.17	0.30
Reach-1	10.4*	50.00	97.31	99.07	98.27	99.13	0.001967	1.94	25.78	23.95	0.33
Reach-1	10.4*	60.00	97.31	99.16	98.37	99.23	0.002333	2.14	27.98	25.41	0.36
Reach-1	10.4*	70.00	97.31	99.25	98.45	99.33	0.002617	2.31	30.30	26.82	0.38
Reach-1	10.4*	80.00	97.31	99.35	98.53	99.44	0.002682	2.41	33.18	28.04	0.39
Reach-1	10.4*	90.00	97.31	99.46	98.60	99.56	0.002612	2.49	36.21	28.62	0.39
Reach-1	10.4*	100.00	97.31	99.57	98.67	99.67	0.002498	2.55	39.26	28.85	0.38
Reach-1	10.4*	200.00	97.31	101.20	99.33	101.24	0.000450	1.79	209.60	251.89	0.18
Reach-1	10.4*	500.00	97.31	101.30	100.63	101.50	0.002326	4.16	235.42	271.83	0.42
Reach-1	10.4*	750.00	97.31	101.70	101.21	101.92	0.002427	4.62	363.26	354.39	0.44
Reach-1	10.4*	1000.00	97.31	102.00	101.52	102.22	0.002473	4.93	477.78	399.00	0.45
Reach-1	10.4*	1500.00	97.31	102.45	102.01	102.66	0.002497	5.34	654.44	399.00	0.46
Reach-1	10.2*	10.00	97.55	98.44	98.02	98.45	0.001199	1.01	9.92	17.32	0.23
Reach-1	10.2*	20.00	97.55	98.64	98.18	98.67	0.002060	1.44	13.86	21.16	0.31
Reach-1	10.2*	30.00	97.55	98.78	98.31	98.83	0.002702	1.76	17.09	23.79	0.37
Reach-1	10.2*	40.00	97.55	98.90	98.40	98.96	0.003162	2.00	20.00	25.73	0.40
Reach-1	10.2*	50.00	97.55	99.00	98.51	99.08	0.003483	2.21	22.61	26.89	0.42
Reach-1	10.2*	60.00	97.55	99.08	98.60	99.17	0.003760	2.42	24.76	27.13	0.45
Reach-1	10.2*	70.00	97.55	99.16	98.69	99.27	0.003878	2.59	27.00	27.29	0.46
Reach-1	10.2*	80.00	97.55	99.27	98.76	99.38	0.003647	2.67	29.93	27.50	0.45
Reach-1	10.2*	90.00	97.55	99.38	98.83	99.50	0.003389	2.73	32.98	27.71	0.44
Reach-1	10.2*	100.00	97.55	99.49	98.89	99.61	0.003153	2.77	36.05	27.92	0.43
Reach-1	10.2*	200.00	97.55	101.19	99.36	101.23	0.000451	1.79	216.30	259.60	0.18
Reach-1	10.2*	500.00	97.55	101.22	100.70	101.45	0.002659	4.39	224.15	265.65	0.45
Reach-1	10.2*	750.00	97.55	101.64	101.21	101.87	0.002656	4.79	353.96	350.92	0.46
Reach-1	10.2*	1000.00	97.55	101.94	101.51	102.17	0.002670	5.08	468.79	398.50	0.47
Reach-1	10.2*	1500.00	97.55	102.39	101.97	102.61	0.002627	5.44	647.39	398.50	0.47
Reach-1	10	10.00	97.80	98.26	98.26	98.38	0.030134	2.76	3.63	15.84	1.01
Reach-1	10	20.00	97.80	98.41	98.41	98.56	0.025991	3.12	6.42	20.87	0.99
Reach-1	10	30.00	97.80	98.52	98.52	98.70	0.024654	3.41	8.79	23.96	0.99
Reach-1	10	40.00	97.80	98.59	98.59	98.81	0.024472	3.77	10.62	24.77	1.01
Reach-1	10	50.00	97.80	98.66	98.66	98.91	0.023640	4.04	12.38	25.35	1.02
Reach-1	10	60.00	97.80	98.75	98.73	99.01	0.019651	4.09	14.66	25.52	0.95
Reach-1	10	70.00	97.80	98.93	98.79	99.13	0.011014	3.63	19.29	25.88	0.74

Reach-1	10	80.00	97.80	99.09	98.84	99.27	0.007673	3.41	23.46	26.20	0.64
Reach-1	10	90.00	97.80	99.23	98.90	99.40	0.006091	3.32	27.14	26.47	0.58
Reach-1	10	100.00	97.80	99.36	98.95	99.53	0.005135	3.27	30.60	26.73	0.54
Reach-1	10	200.00	97.80	101.18	99.41	101.22	0.000468	1.81	222.33	267.28	0.19
Reach-1	10	500.00	97.80	101.12	100.76	101.39	0.003306	4.74	206.66	255.11	0.50
Reach-1	10	750.00	97.80	101.56	101.21	101.81	0.003080	5.04	338.53	344.33	0.49
Reach-1	10	1000.00	97.80	101.87	101.50	102.11	0.003015	5.30	454.75	398.00	0.49
Reach-1	10	1500.00	97.80	102.33	101.94	102.56	0.002828	5.56	637.83	398.00	0.49

Design Channel: Bankfull Discharge = 150 cfs; slope = 0.0031 ft/ft

Profile Output Table - Standard Table 1
HEC-RAS Plan: q150sp31 River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 618
Plans = 1
Profiles = 15

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	20	10.00	101.00	101.54	101.43	101.59	0.008702	1.70	5.88	20.90	0.56
Reach-1	20	20.00	101.00	101.72	101.57	101.78	0.007191	1.99	10.05	24.39	0.55
Reach-1	20	30.00	101.00	101.87	101.67	101.95	0.005846	2.18	13.78	24.84	0.52
Reach-1	20	40.00	101.00	102.01	101.76	102.09	0.005117	2.33	17.14	25.08	0.50
Reach-1	20	50.00	101.00	102.13	101.81	102.23	0.004684	2.47	20.23	25.30	0.49
Reach-1	20	60.00	101.00	102.25	101.88	102.35	0.004363	2.59	23.17	25.50	0.48
Reach-1	20	70.00	101.00	102.36	101.94	102.47	0.004148	2.70	25.93	25.69	0.47
Reach-1	20	80.00	101.00	102.46	102.00	102.58	0.004001	2.81	28.52	25.87	0.47
Reach-1	20	90.00	101.00	102.55	102.06	102.68	0.003898	2.91	30.97	26.03	0.47
Reach-1	20	100.00	101.00	102.64	102.11	102.78	0.003820	3.00	33.31	26.19	0.47
Reach-1	20	200.00	101.00	103.33	102.58	103.55	0.003696	3.84	56.87	72.94	0.49
Reach-1	20	500.00	101.00	104.24	103.93	104.51	0.003477	4.82	207.79	257.93	0.51
Reach-1	20	750.00	101.00	104.65	104.34	104.91	0.003352	5.19	331.95	341.88	0.51
Reach-1	20	1000.00	101.00	104.96	104.62	105.21	0.003276	5.45	445.91	397.00	0.51
Reach-1	20	1500.00	101.00	105.38	105.05	105.63	0.003212	5.82	614.27	397.00	0.51
Reach-1	19.8*	10.00	100.75	101.31	101.22	101.38	0.011666	2.14	4.68	14.66	0.67
Reach-1	19.8*	20.00	100.75	101.55	101.38	101.63	0.008813	2.29	8.73	19.96	0.61
Reach-1	19.8*	30.00	100.75	101.74	101.51	101.82	0.006685	2.32	12.95	23.59	0.55
Reach-1	19.8*	40.00	100.75	101.90	101.61	101.99	0.005419	2.36	16.98	25.74	0.51
Reach-1	19.8*	50.00	100.75	102.04	101.70	102.13	0.004535	2.43	20.60	25.98	0.48
Reach-1	19.8*	60.00	100.75	102.17	101.77	102.27	0.004061	2.51	23.88	26.19	0.46
Reach-1	19.8*	70.00	100.75	102.28	101.84	102.39	0.003789	2.61	26.87	26.38	0.45
Reach-1	19.8*	80.00	100.75	102.39	101.90	102.50	0.003619	2.70	29.64	26.56	0.45
Reach-1	19.8*	90.00	100.75	102.48	101.96	102.60	0.003508	2.79	32.23	26.72	0.45
Reach-1	19.8*	100.00	100.75	102.58	102.01	102.70	0.003427	2.88	34.70	26.88	0.45
Reach-1	19.8*	200.00	100.75	103.27	102.48	103.48	0.003331	3.69	59.04	74.19	0.47
Reach-1	19.8*	500.00	100.75	104.17	103.82	104.44	0.003300	4.74	209.08	257.81	0.50
Reach-1	19.8*	750.00	100.75	104.58	104.26	104.84	0.003242	5.14	332.06	341.21	0.50
Reach-1	19.8*	1000.00	100.75	104.88	104.54	105.14	0.003262	5.46	441.98	397.31	0.51
Reach-1	19.8*	1500.00	100.75	105.31	104.98	105.56	0.003156	5.80	614.08	397.33	0.51
Reach-1	19.6*	10.00	100.51	101.14	100.98	101.20	0.007042	1.91	5.24	13.26	0.54
Reach-1	19.6*	20.00	100.51	101.41	101.16	101.48	0.005766	2.19	9.14	16.17	0.51
Reach-1	19.6*	30.00	100.51	101.62	101.30	101.70	0.005541	2.34	12.84	19.94	0.51
Reach-1	19.6*	40.00	100.51	101.79	101.41	101.88	0.004998	2.40	16.68	23.06	0.50
Reach-1	19.6*	50.00	100.51	101.95	101.53	102.04	0.004521	2.44	20.47	25.50	0.48
Reach-1	19.6*	60.00	100.51	102.09	101.62	102.18	0.004065	2.49	24.10	26.85	0.46
Reach-1	19.6*	70.00	100.51	102.21	101.71	102.31	0.003670	2.56	27.38	27.05	0.45
Reach-1	19.6*	80.00	100.51	102.32	101.78	102.43	0.003447	2.64	30.36	27.24	0.44

Reach-1	19.6*	90.00	100.51	102.42	101.86	102.53	0.003310	2.72	33.10	27.41	0.44
Reach-1	19.6*	100.00	100.51	102.51	101.92	102.64	0.003215	2.80	35.70	27.57	0.43
Reach-1	19.6*	200.00	100.51	103.21	102.39	103.41	0.003082	3.57	61.44	77.89	0.45
Reach-1	19.6*	500.00	100.51	104.12	103.72	104.37	0.003092	4.61	214.23	260.61	0.48
Reach-1	19.6*	750.00	100.51	104.53	104.17	104.78	0.003079	5.03	337.43	343.21	0.49
Reach-1	19.6*	1000.00	100.51	104.82	104.46	105.08	0.003095	5.35	448.70	397.67	0.50
Reach-1	19.6*	1500.00	100.51	105.25	104.91	105.50	0.003052	5.73	619.02	397.67	0.51
Reach-1	19.4*	10.00	100.26	101.09	100.74	101.12	0.002374	1.37	7.32	13.41	0.33
Reach-1	19.4*	20.00	100.26	101.35	100.93	101.40	0.002936	1.81	11.06	15.56	0.38
Reach-1	19.4*	30.00	100.26	101.54	101.08	101.61	0.003263	2.10	14.30	17.37	0.41
Reach-1	19.4*	40.00	100.26	101.72	101.20	101.80	0.003604	2.28	17.55	20.27	0.43
Reach-1	19.4*	50.00	100.26	101.87	101.31	101.96	0.003690	2.39	20.88	22.81	0.44
Reach-1	19.4*	60.00	100.26	102.01	101.41	102.11	0.003676	2.48	24.24	25.10	0.44
Reach-1	19.4*	70.00	100.26	102.14	101.50	102.24	0.003579	2.54	27.53	26.84	0.44
Reach-1	19.4*	80.00	100.26	102.25	101.60	102.36	0.003436	2.61	30.66	27.84	0.44
Reach-1	19.4*	90.00	100.26	102.36	101.69	102.47	0.003253	2.68	33.58	28.03	0.43
Reach-1	19.4*	100.00	100.26	102.45	101.77	102.57	0.003131	2.75	36.32	28.20	0.43
Reach-1	19.4*	200.00	100.26	103.16	102.32	103.35	0.002939	3.49	63.06	79.96	0.44
Reach-1	19.4*	500.00	100.26	104.06	103.64	104.30	0.002976	4.52	217.15	262.46	0.47
Reach-1	19.4*	750.00	100.26	104.47	104.09	104.71	0.002988	4.95	340.48	344.82	0.48
Reach-1	19.4*	1000.00	100.26	104.77	104.38	105.01	0.002984	5.25	453.59	398.00	0.49
Reach-1	19.4*	1500.00	100.26	105.19	104.84	105.43	0.002989	5.66	622.06	398.00	0.50
Reach-1	19.2*	10.00	100.01	101.07	100.48	101.08	0.000926	1.02	9.84	13.73	0.21
Reach-1	19.2*	20.00	100.01	101.32	100.68	101.35	0.001533	1.49	13.44	15.36	0.28
Reach-1	19.2*	30.00	100.01	101.51	100.85	101.56	0.001942	1.82	16.48	16.56	0.32
Reach-1	19.2*	40.00	100.01	101.67	100.98	101.74	0.002354	2.07	19.29	18.41	0.36
Reach-1	19.2*	50.00	100.01	101.82	101.10	101.89	0.002705	2.26	22.16	20.70	0.38
Reach-1	19.2*	60.00	100.01	101.95	101.20	102.04	0.002916	2.39	25.10	22.74	0.40
Reach-1	19.2*	70.00	100.01	102.07	101.30	102.17	0.003051	2.50	28.03	24.62	0.41
Reach-1	19.2*	80.00	100.01	102.19	101.39	102.29	0.003146	2.59	30.90	26.32	0.42
Reach-1	19.2*	90.00	100.01	102.29	101.47	102.40	0.003185	2.67	33.76	27.77	0.43
Reach-1	19.2*	100.00	100.01	102.39	101.55	102.51	0.003157	2.73	36.57	28.75	0.43
Reach-1	19.2*	200.00	100.01	103.11	102.24	103.29	0.002872	3.43	64.35	81.93	0.43
Reach-1	19.2*	500.00	100.01	104.01	103.56	104.24	0.002899	4.44	219.85	264.03	0.46
Reach-1	19.2*	750.00	100.01	104.41	104.02	104.65	0.002925	4.88	343.22	345.98	0.48
Reach-1	19.2*	1000.00	100.01	104.72	104.31	104.95	0.002900	5.16	458.09	398.33	0.48
Reach-1	19.2*	1500.00	100.01	105.13	104.77	105.37	0.002947	5.60	624.47	398.33	0.50
Reach-1	19.*	10.00	99.77	101.06	100.24	101.07	0.000461	0.81	12.28	13.93	0.15
Reach-1	19.*	20.00	99.77	101.30	100.45	101.32	0.000911	1.27	15.77	15.27	0.22
Reach-1	19.*	30.00	99.77	101.48	100.62	101.52	0.001279	1.61	18.67	16.29	0.26
Reach-1	19.*	40.00	99.77	101.64	100.76	101.69	0.001581	1.88	21.28	17.15	0.30
Reach-1	19.*	50.00	99.77	101.78	100.88	101.85	0.001962	2.10	23.78	19.07	0.33
Reach-1	19.*	60.00	99.77	101.90	101.00	101.99	0.002272	2.28	26.34	20.95	0.36
Reach-1	19.*	70.00	99.77	102.02	101.10	102.11	0.002507	2.42	28.92	22.62	0.38
Reach-1	19.*	80.00	99.77	102.13	101.20	102.23	0.002698	2.54	31.45	24.16	0.39
Reach-1	19.*	90.00	99.77	102.23	101.28	102.34	0.002846	2.65	33.99	25.60	0.41
Reach-1	19.*	100.00	99.77	102.33	101.37	102.45	0.002959	2.74	36.53	26.97	0.41
Reach-1	19.*	200.00	99.77	103.05	102.11	103.23	0.002910	3.41	65.42	85.29	0.43
Reach-1	19.*	500.00	99.77	103.96	103.48	104.18	0.002817	4.34	225.44	268.10	0.46
Reach-1	19.*	750.00	99.77	104.36	103.95	104.59	0.002835	4.76	350.32	349.71	0.47
Reach-1	19.*	1000.00	99.77	104.67	104.23	104.89	0.002798	5.03	466.09	398.67	0.47
Reach-1	19.*	1500.00	99.77	105.08	104.70	105.31	0.002869	5.48	631.72	398.67	0.49
Reach-1	18.8	10.00	99.52	101.06	99.99	101.06	0.000262	0.68	14.72	14.08	0.12
Reach-1	18.8	20.00	99.52	101.29	100.21	101.31	0.000585	1.10	18.15	15.23	0.18
Reach-1	18.8	30.00	99.52	101.47	100.39	101.50	0.000883	1.43	20.95	16.11	0.22

Reach-1	18.8	40.00	99.52	101.62	100.54	101.66	0.001150	1.71	23.44	16.85	0.26
Reach-1	18.8	50.00	99.52	101.75	100.67	101.81	0.001417	1.94	25.71	17.78	0.28
Reach-1	18.8	60.00	99.52	101.87	100.79	101.94	0.001730	2.15	27.97	19.43	0.32
Reach-1	18.8	70.00	99.52	101.98	100.90	102.07	0.002004	2.32	30.23	20.96	0.34
Reach-1	18.8	80.00	99.52	102.09	101.00	102.18	0.002247	2.47	32.45	22.36	0.36
Reach-1	18.8	90.00	99.52	102.18	101.09	102.29	0.002455	2.59	34.68	23.68	0.38
Reach-1	18.8	100.00	99.52	102.28	101.18	102.39	0.002630	2.71	36.93	24.94	0.39
Reach-1	18.8	200.00	99.52	102.99	101.94	103.17	0.003064	3.42	65.19	85.83	0.44
Reach-1	18.8	500.00	99.52	103.91	103.43	104.12	0.002817	4.27	228.29	270.80	0.45
Reach-1	18.8	750.00	99.52	104.31	103.88	104.53	0.002811	4.68	354.66	352.76	0.46
Reach-1	18.8	1000.00	99.52	104.62	104.16	104.83	0.002748	4.92	471.77	399.00	0.46
Reach-1	18.8	1500.00	99.52	105.03	104.63	105.25	0.002829	5.38	636.84	399.00	0.48
Reach-1	18.6*	10.00	99.73	101.05	100.20	101.06	0.000402	0.77	13.04	14.68	0.14
Reach-1	18.6*	20.00	99.73	101.27	100.41	101.29	0.000833	1.21	16.48	16.01	0.21
Reach-1	18.6*	30.00	99.73	101.44	100.58	101.48	0.001207	1.56	19.29	17.02	0.26
Reach-1	18.6*	40.00	99.73	101.58	100.71	101.64	0.001639	1.83	21.86	19.04	0.30
Reach-1	18.6*	50.00	99.73	101.71	100.83	101.78	0.002021	2.05	24.38	20.97	0.34
Reach-1	18.6*	60.00	99.73	101.83	100.94	101.90	0.002320	2.23	26.91	22.64	0.36
Reach-1	18.6*	70.00	99.73	101.93	101.04	102.02	0.002556	2.38	29.44	24.20	0.38
Reach-1	18.6*	80.00	99.73	102.03	101.14	102.13	0.002752	2.51	31.92	25.64	0.40
Reach-1	18.6*	90.00	99.73	102.13	101.22	102.23	0.002901	2.61	34.42	27.01	0.41
Reach-1	18.6*	100.00	99.73	102.22	101.31	102.33	0.003007	2.71	36.94	28.28	0.42
Reach-1	18.6*	200.00	99.73	102.93	102.02	103.11	0.002829	3.40	65.69	85.40	0.43
Reach-1	18.6*	500.00	99.73	103.84	103.37	104.06	0.002757	4.33	227.15	269.60	0.45
Reach-1	18.6*	750.00	99.73	104.24	103.83	104.47	0.002829	4.79	349.84	349.82	0.47
Reach-1	18.6*	1000.00	99.73	104.55	104.11	104.77	0.002781	5.04	466.51	398.50	0.47
Reach-1	18.6*	1500.00	99.73	104.96	104.58	105.19	0.002854	5.50	632.27	398.50	0.49
Reach-1	18.4*	10.00	99.94	101.03	100.42	101.04	0.000718	0.90	11.13	15.58	0.19
Reach-1	18.4*	20.00	99.94	101.24	100.61	101.27	0.001379	1.37	14.58	17.56	0.27
Reach-1	18.4*	30.00	99.94	101.40	100.76	101.45	0.002017	1.70	17.60	20.36	0.32
Reach-1	18.4*	40.00	99.94	101.54	100.88	101.60	0.002472	1.95	20.48	22.50	0.36
Reach-1	18.4*	50.00	99.94	101.66	100.99	101.73	0.002807	2.15	23.29	24.40	0.39
Reach-1	18.4*	60.00	99.94	101.77	101.09	101.85	0.003018	2.30	26.12	26.10	0.40
Reach-1	18.4*	70.00	99.94	101.87	101.18	101.96	0.003129	2.42	28.97	27.55	0.42
Reach-1	18.4*	80.00	99.94	101.97	101.29	102.07	0.003078	2.52	31.74	27.91	0.42
Reach-1	18.4*	90.00	99.94	102.07	101.37	102.17	0.003015	2.62	34.40	28.07	0.42
Reach-1	18.4*	100.00	99.94	102.16	101.45	102.27	0.002962	2.71	36.96	28.23	0.42
Reach-1	18.4*	200.00	99.94	102.87	101.99	103.05	0.002791	3.43	65.05	84.52	0.43
Reach-1	18.4*	500.00	99.94	103.78	103.32	104.01	0.002795	4.42	225.08	268.75	0.46
Reach-1	18.4*	750.00	99.94	104.17	103.78	104.41	0.002882	4.88	346.81	348.90	0.48
Reach-1	18.4*	1000.00	99.94	104.48	104.07	104.71	0.002825	5.13	463.79	398.00	0.48
Reach-1	18.4*	1500.00	99.94	104.90	104.53	105.13	0.002892	5.59	629.53	398.00	0.49
Reach-1	18.2*	10.00	100.16	101.00	100.63	101.02	0.001851	1.14	8.79	17.74	0.29
Reach-1	18.2*	20.00	100.16	101.19	100.80	101.23	0.002932	1.60	12.52	21.43	0.37
Reach-1	18.2*	30.00	100.16	101.34	100.94	101.39	0.003526	1.89	15.83	24.06	0.41
Reach-1	18.2*	40.00	100.16	101.47	101.05	101.53	0.003737	2.10	19.03	25.82	0.43
Reach-1	18.2*	50.00	100.16	101.58	101.15	101.66	0.003663	2.26	22.12	26.41	0.44
Reach-1	18.2*	60.00	100.16	101.69	101.23	101.78	0.003525	2.39	25.08	26.60	0.43
Reach-1	18.2*	70.00	100.16	101.80	101.31	101.90	0.003408	2.51	27.90	26.78	0.43
Reach-1	18.2*	80.00	100.16	101.90	101.38	102.01	0.003315	2.61	30.60	26.95	0.43
Reach-1	18.2*	90.00	100.16	102.00	101.44	102.11	0.003238	2.71	33.20	27.11	0.43
Reach-1	18.2*	100.00	100.16	102.09	101.51	102.21	0.003176	2.80	35.69	27.26	0.43
Reach-1	18.2*	200.00	100.16	102.80	101.95	103.00	0.003004	3.56	62.93	82.96	0.45
Reach-1	18.2*	500.00	100.16	103.71	103.30	103.95	0.002933	4.52	222.54	267.44	0.47
Reach-1	18.2*	750.00	100.16	104.11	103.74	104.35	0.002969	4.96	345.75	348.46	0.48
Reach-1	18.2*	1000.00	100.16	104.42	104.02	104.65	0.002902	5.21	462.29	397.50	0.48

Reach-1	18.2*	1500.00	100.16	104.84	104.47	105.07	0.002943	5.64	628.72	397.50	0.50
Reach-1	18	10.00	100.37	100.89	100.80	100.94	0.010777	1.84	5.44	20.20	0.62
Reach-1	18	20.00	100.37	101.06	100.94	101.13	0.009468	2.18	9.18	23.93	0.62
Reach-1	18	30.00	100.37	101.21	101.04	101.29	0.007250	2.33	12.89	24.78	0.57
Reach-1	18	40.00	100.37	101.34	101.13	101.44	0.006056	2.46	16.27	25.02	0.54
Reach-1	18	50.00	100.37	101.47	101.18	101.57	0.005339	2.57	19.43	25.24	0.52
Reach-1	18	60.00	100.37	101.59	101.25	101.70	0.004844	2.68	22.43	25.45	0.50
Reach-1	18	70.00	100.37	101.70	101.31	101.82	0.004505	2.77	25.26	25.64	0.49
Reach-1	18	80.00	100.37	101.80	101.37	101.93	0.004270	2.86	27.94	25.83	0.49
Reach-1	18	90.00	100.37	101.90	101.43	102.04	0.004094	2.95	30.49	26.00	0.48
Reach-1	18	100.00	100.37	102.00	101.48	102.14	0.003961	3.04	32.93	26.16	0.48
Reach-1	18	200.00	100.37	102.70	101.95	102.93	0.003640	3.82	57.45	74.54	0.49
Reach-1	18	500.00	100.37	103.63	103.30	103.89	0.003351	4.76	212.35	261.49	0.50
Reach-1	18	750.00	100.37	104.04	103.72	104.30	0.003214	5.10	339.26	346.18	0.50
Reach-1	18	1000.00	100.37	104.36	103.99	104.60	0.003045	5.29	459.41	397.00	0.49
Reach-1	18	1500.00	100.37	104.78	104.42	105.01	0.003071	5.71	624.42	397.00	0.50
Reach-1	17.8*	10.00	100.13	100.64	100.56	100.71	0.011729	2.09	4.78	15.53	0.66
Reach-1	17.8*	20.00	100.13	100.88	100.71	100.96	0.008118	2.26	8.84	19.34	0.59
Reach-1	17.8*	30.00	100.13	101.07	100.83	101.16	0.006480	2.31	12.98	23.25	0.55
Reach-1	17.8*	40.00	100.13	101.24	100.94	101.32	0.005140	2.36	16.97	24.76	0.50
Reach-1	17.8*	50.00	100.13	101.38	101.03	101.47	0.004370	2.43	20.55	25.18	0.47
Reach-1	17.8*	60.00	100.13	101.51	101.10	101.61	0.003936	2.52	23.82	25.49	0.46
Reach-1	17.8*	70.00	100.13	101.63	101.17	101.73	0.003674	2.61	26.83	25.77	0.45
Reach-1	17.8*	80.00	100.13	101.74	101.23	101.85	0.003508	2.70	29.64	26.04	0.45
Reach-1	17.8*	90.00	100.13	101.84	101.29	101.96	0.003391	2.79	32.30	26.28	0.44
Reach-1	17.8*	100.00	100.13	101.93	101.35	102.06	0.003306	2.87	34.84	26.52	0.44
Reach-1	17.8*	200.00	100.13	102.65	101.82	102.86	0.003159	3.64	60.39	76.76	0.46
Reach-1	17.8*	500.00	100.13	103.57	103.19	103.82	0.003102	4.65	215.06	261.85	0.48
Reach-1	17.8*	750.00	100.13	103.98	103.63	104.23	0.003053	5.04	340.62	345.60	0.49
Reach-1	17.8*	1000.00	100.13	104.29	103.91	104.53	0.002949	5.27	459.14	397.33	0.49
Reach-1	17.8*	1500.00	100.13	104.71	104.36	104.95	0.003000	5.71	624.27	397.33	0.50
Reach-1	17.6*	10.00	99.89	100.52	100.32	100.56	0.004959	1.65	6.06	14.72	0.45
Reach-1	17.6*	20.00	99.89	100.78	100.49	100.84	0.004301	1.95	10.27	17.40	0.45
Reach-1	17.6*	30.00	99.89	100.98	100.62	101.05	0.004191	2.15	13.98	20.10	0.45
Reach-1	17.6*	40.00	99.89	101.15	100.72	101.23	0.004027	2.25	17.77	23.05	0.45
Reach-1	17.6*	50.00	99.89	101.31	100.83	101.39	0.003666	2.33	21.47	24.64	0.44
Reach-1	17.6*	60.00	99.89	101.44	100.92	101.53	0.003360	2.41	24.89	25.37	0.43
Reach-1	17.6*	70.00	99.89	101.57	101.01	101.66	0.003162	2.50	28.03	25.77	0.42
Reach-1	17.6*	80.00	99.89	101.68	101.09	101.78	0.003049	2.59	30.92	26.13	0.42
Reach-1	17.6*	90.00	99.89	101.78	101.16	101.89	0.002972	2.67	33.65	26.47	0.42
Reach-1	17.6*	100.00	99.89	101.88	101.22	102.00	0.002920	2.76	36.25	26.79	0.42
Reach-1	17.6*	200.00	99.89	102.60	101.72	102.79	0.002873	3.51	62.86	79.49	0.44
Reach-1	17.6*	500.00	99.89	103.51	103.08	103.75	0.002916	4.54	218.60	263.38	0.47
Reach-1	17.6*	750.00	99.89	103.92	103.55	104.17	0.002920	4.96	343.64	346.39	0.48
Reach-1	17.6*	1000.00	99.89	104.23	103.83	104.47	0.002856	5.21	461.20	397.67	0.48
Reach-1	17.6*	1500.00	99.89	104.65	104.29	104.89	0.002932	5.68	625.89	397.67	0.50
Reach-1	17.4*	10.00	99.65	100.48	100.08	100.50	0.001663	1.19	8.43	14.68	0.28
Reach-1	17.4*	20.00	99.65	100.73	100.25	100.77	0.002180	1.61	12.42	16.70	0.33
Reach-1	17.4*	30.00	99.65	100.93	100.40	100.98	0.002466	1.90	15.81	18.21	0.36
Reach-1	17.4*	40.00	99.65	101.09	100.52	101.16	0.002787	2.10	19.08	20.76	0.39
Reach-1	17.4*	50.00	99.65	101.25	100.62	101.32	0.002937	2.23	22.43	23.15	0.40
Reach-1	17.4*	60.00	99.65	101.39	100.72	101.47	0.002906	2.33	25.78	24.72	0.40
Reach-1	17.4*	70.00	99.65	101.51	100.81	101.60	0.002817	2.42	28.93	25.53	0.40
Reach-1	17.4*	80.00	99.65	101.62	100.89	101.72	0.002754	2.51	31.85	26.05	0.40
Reach-1	17.4*	90.00	99.65	101.73	100.98	101.83	0.002714	2.60	34.61	26.52	0.40

Reach-1	17.4*	100.00	99.65	101.83	101.06	101.94	0.002691	2.68	37.25	26.96	0.40
Reach-1	17.4*	200.00	99.65	102.55	101.62	102.73	0.002710	3.42	64.90	82.30	0.43
Reach-1	17.4*	500.00	99.65	103.46	103.00	103.69	0.002786	4.45	222.06	264.88	0.46
Reach-1	17.4*	750.00	99.65	103.87	103.47	104.11	0.002824	4.88	346.55	346.95	0.47
Reach-1	17.4*	1000.00	99.65	104.18	103.76	104.41	0.002793	5.16	463.00	398.00	0.48
Reach-1	17.4*	1500.00	99.65	104.59	104.23	104.83	0.002888	5.63	627.17	398.00	0.49
Reach-1	17.2*	10.00	99.40	100.46	99.84	100.48	0.000723	0.92	10.83	14.57	0.19
Reach-1	17.2*	20.00	99.40	100.71	100.03	100.74	0.001237	1.37	14.60	16.18	0.25
Reach-1	17.2*	30.00	99.40	100.89	100.18	100.94	0.001603	1.69	17.74	17.38	0.29
Reach-1	17.2*	40.00	99.40	101.05	100.31	101.11	0.001925	1.94	20.63	18.87	0.33
Reach-1	17.2*	50.00	99.40	101.20	100.43	101.27	0.002238	2.12	23.53	21.02	0.35
Reach-1	17.2*	60.00	99.40	101.34	100.53	101.41	0.002442	2.26	26.51	23.01	0.37
Reach-1	17.2*	70.00	99.40	101.46	100.62	101.55	0.002565	2.38	29.47	24.69	0.38
Reach-1	17.2*	80.00	99.40	101.57	100.71	101.67	0.002578	2.48	32.31	25.51	0.39
Reach-1	17.2*	90.00	99.40	101.68	100.80	101.78	0.002592	2.57	35.03	26.26	0.39
Reach-1	17.2*	100.00	99.40	101.78	100.87	101.89	0.002600	2.66	37.65	26.86	0.40
Reach-1	17.2*	200.00	99.40	102.50	101.54	102.68	0.002691	3.37	65.61	83.03	0.42
Reach-1	17.2*	500.00	99.40	103.41	102.92	103.63	0.002761	4.39	223.02	265.84	0.46
Reach-1	17.2*	750.00	99.40	103.81	103.40	104.05	0.002805	4.83	347.42	347.96	0.47
Reach-1	17.2*	1000.00	99.40	104.12	103.67	104.35	0.002779	5.11	463.49	398.33	0.48
Reach-1	17.2*	1500.00	99.40	104.53	104.16	104.77	0.002878	5.59	627.57	398.33	0.49
Reach-1	17.*	10.00	99.16	100.45	99.61	100.46	0.000406	0.78	12.89	14.36	0.14
Reach-1	17.*	20.00	99.16	100.69	99.82	100.71	0.000814	1.22	16.45	15.68	0.21
Reach-1	17.*	30.00	99.16	100.87	99.98	100.91	0.001157	1.55	19.38	16.68	0.25
Reach-1	17.*	40.00	99.16	101.03	100.12	101.08	0.001439	1.82	22.03	17.54	0.29
Reach-1	17.*	50.00	99.16	101.16	100.24	101.23	0.001767	2.04	24.54	19.20	0.32
Reach-1	17.*	60.00	99.16	101.29	100.35	101.37	0.002052	2.21	27.13	21.02	0.34
Reach-1	17.*	70.00	99.16	101.41	100.45	101.50	0.002278	2.36	29.72	22.69	0.36
Reach-1	17.*	80.00	99.16	101.52	100.55	101.62	0.002460	2.48	32.30	24.25	0.38
Reach-1	17.*	90.00	99.16	101.62	100.64	101.73	0.002567	2.58	34.86	25.39	0.39
Reach-1	17.*	100.00	99.16	101.72	100.72	101.83	0.002634	2.68	37.38	26.30	0.40
Reach-1	17.*	200.00	99.16	102.45	101.45	102.62	0.002808	3.38	65.77	84.60	0.43
Reach-1	17.*	500.00	99.16	103.35	102.87	103.58	0.002764	4.33	225.66	268.12	0.45
Reach-1	17.*	750.00	99.16	103.76	103.34	103.99	0.002789	4.76	351.03	350.19	0.47
Reach-1	17.*	1000.00	99.16	104.07	103.63	104.29	0.002747	5.01	467.77	398.67	0.47
Reach-1	17.*	1500.00	99.16	104.48	104.10	104.71	0.002855	5.50	631.15	398.67	0.49
Reach-1	16.8	10.00	98.92	100.45	99.39	100.46	0.000267	0.68	14.64	14.05	0.12
Reach-1	16.8	20.00	98.92	100.68	99.62	100.70	0.000597	1.11	18.01	15.18	0.18
Reach-1	16.8	30.00	98.92	100.85	99.79	100.89	0.000907	1.45	20.74	16.05	0.22
Reach-1	16.8	40.00	98.92	101.00	99.94	101.05	0.001183	1.72	23.20	16.78	0.26
Reach-1	16.8	50.00	98.92	101.14	100.07	101.20	0.001445	1.96	25.45	17.57	0.29
Reach-1	16.8	60.00	98.92	101.26	100.19	101.33	0.001766	2.17	27.68	19.23	0.32
Reach-1	16.8	70.00	98.92	101.37	100.30	101.45	0.002047	2.34	29.92	20.76	0.34
Reach-1	16.8	80.00	98.92	101.47	100.40	101.57	0.002293	2.49	32.15	22.17	0.36
Reach-1	16.8	90.00	98.92	101.57	100.49	101.68	0.002505	2.62	34.38	23.50	0.38
Reach-1	16.8	100.00	98.92	101.66	100.58	101.78	0.002682	2.73	36.62	24.77	0.40
Reach-1	16.8	200.00	98.92	102.38	101.34	102.56	0.003123	3.44	64.39	83.92	0.44
Reach-1	16.8	500.00	98.92	103.30	102.83	103.52	0.002839	4.29	227.25	270.02	0.45
Reach-1	16.8	750.00	98.92	103.71	103.28	103.93	0.002818	4.68	354.18	352.49	0.46
Reach-1	16.8	1000.00	98.92	104.02	103.56	104.23	0.002741	4.91	472.25	399.00	0.46
Reach-1	16.8	1500.00	98.92	104.43	104.03	104.65	0.002852	5.39	634.94	399.00	0.48
Reach-1	16.6*	10.00	99.13	100.44	99.57	100.45	0.000339	0.72	13.92	15.30	0.13
Reach-1	16.6*	20.00	99.13	100.67	99.77	100.69	0.000712	1.14	17.48	16.63	0.20
Reach-1	16.6*	30.00	99.13	100.83	99.93	100.87	0.001043	1.47	20.37	17.63	0.24
Reach-1	16.6*	40.00	99.13	100.98	100.06	101.02	0.001396	1.74	23.00	19.31	0.28

Reach-1	16.6*	50.00	99.13	101.10	100.18	101.16	0.001727	1.96	25.57	21.14	0.31
Reach-1	16.6*	60.00	99.13	101.22	100.29	101.29	0.002001	2.13	28.13	22.82	0.34
Reach-1	16.6*	70.00	99.13	101.33	100.39	101.41	0.002224	2.28	30.69	24.38	0.36
Reach-1	16.6*	80.00	99.13	101.43	100.48	101.52	0.002350	2.41	33.21	25.33	0.37
Reach-1	16.6*	90.00	99.13	101.53	100.56	101.63	0.002443	2.52	35.67	26.10	0.38
Reach-1	16.6*	100.00	99.13	101.62	100.65	101.72	0.002516	2.63	38.08	26.81	0.39
Reach-1	16.6*	200.00	99.13	102.33	101.35	102.50	0.002718	3.36	66.02	84.40	0.42
Reach-1	16.6*	500.00	99.13	103.24	102.74	103.46	0.002693	4.32	227.42	269.24	0.45
Reach-1	16.6*	750.00	99.13	103.64	103.22	103.87	0.002787	4.79	349.54	349.21	0.47
Reach-1	16.6*	1000.00	99.13	103.95	103.51	104.17	0.002731	5.04	467.56	398.50	0.47
Reach-1	16.6*	1500.00	99.13	104.35	103.98	104.59	0.002865	5.55	629.23	398.50	0.49
Reach-1	16.4*	10.00	99.35	100.43	99.78	100.44	0.000553	0.81	12.36	16.68	0.17
Reach-1	16.4*	20.00	99.35	100.64	99.96	100.67	0.001048	1.24	16.09	18.39	0.23
Reach-1	16.4*	30.00	99.35	100.80	100.10	100.84	0.001538	1.56	19.24	20.87	0.29
Reach-1	16.4*	40.00	99.35	100.94	100.22	100.99	0.001914	1.80	22.24	22.96	0.32
Reach-1	16.4*	50.00	99.35	101.06	100.33	101.13	0.002167	1.99	25.15	24.53	0.35
Reach-1	16.4*	60.00	99.35	101.18	100.42	101.25	0.002277	2.14	27.99	25.26	0.36
Reach-1	16.4*	70.00	99.35	101.28	100.51	101.36	0.002352	2.28	30.70	25.83	0.37
Reach-1	16.4*	80.00	99.35	101.38	100.59	101.47	0.002406	2.40	33.30	26.27	0.38
Reach-1	16.4*	90.00	99.35	101.48	100.68	101.58	0.002452	2.51	35.79	26.69	0.38
Reach-1	16.4*	100.00	99.35	101.57	100.76	101.67	0.002490	2.62	38.21	27.09	0.39
Reach-1	16.4*	200.00	99.35	102.27	101.32	102.45	0.002650	3.39	65.69	83.97	0.42
Reach-1	16.4*	500.00	99.35	103.18	102.70	103.41	0.002728	4.41	224.62	267.08	0.46
Reach-1	16.4*	750.00	99.35	103.57	103.18	103.81	0.002830	4.89	346.04	347.04	0.47
Reach-1	16.4*	1000.00	99.35	103.88	103.47	104.12	0.002818	5.18	461.11	398.00	0.48
Reach-1	16.4*	1500.00	99.35	104.28	103.94	104.53	0.002954	5.69	621.77	398.00	0.50
Reach-1	16.2*	10.00	99.57	100.41	100.00	100.42	0.001278	1.00	9.98	18.49	0.24
Reach-1	16.2*	20.00	99.57	100.61	100.16	100.64	0.002097	1.43	13.99	22.05	0.32
Reach-1	16.2*	30.00	99.57	100.76	100.28	100.80	0.002541	1.72	17.48	24.17	0.36
Reach-1	16.2*	40.00	99.57	100.89	100.39	100.95	0.002696	1.93	20.71	25.04	0.37
Reach-1	16.2*	50.00	99.57	101.01	100.49	101.08	0.002751	2.11	23.70	25.37	0.38
Reach-1	16.2*	60.00	99.57	101.12	100.58	101.20	0.002768	2.26	26.56	25.69	0.39
Reach-1	16.2*	70.00	99.57	101.22	100.66	101.31	0.002780	2.39	29.27	25.99	0.40
Reach-1	16.2*	80.00	99.57	101.32	100.72	101.42	0.002790	2.51	31.85	26.26	0.40
Reach-1	16.2*	90.00	99.57	101.42	100.79	101.52	0.002804	2.62	34.32	26.53	0.41
Reach-1	16.2*	100.00	99.57	101.50	100.84	101.62	0.002814	2.73	36.69	26.78	0.41
Reach-1	16.2*	200.00	99.57	102.20	101.32	102.39	0.002918	3.54	62.74	80.67	0.44
Reach-1	16.2*	500.00	99.57	103.10	102.69	103.35	0.002961	4.57	218.46	263.77	0.47
Reach-1	16.2*	750.00	99.57	103 51	103.16	103.76	0.002981	5.00	342.02	345.86	0.48
Reach-1	16.2*	1000.00	99.57	103.81	103.43	104.06	0.002966	5.29	455.73	397.50	0.49
Reach-1	16.2*	1500.00	99.57	104.21	103.89	104.47	0.003087	5.79	615.62	397.50	0.51
Reach-1	16	10.00	99.78	100.32	100.21	100.37	0.008635	1.69	5.90	20.93	0.56
Reach-1	16	20.00	99.78	100.50	100.35	100.56	0.007205	1.99	10.05	24.39	0.55
Reach-1	16	30.00	99.78	100.65	100.45	100.73	0.005957	2.19	13.70	24.84	0.52
Reach-1	16	40.00	99.78	100.78	100.54	100.87	0.005229	2.35	17.03	25.07	0.50
Reach-1	16	50.00	99.78	100.91	100.59	101.00	0.004807	2.49	20.07	25.28	0.49
Reach-1	16	60.00	99.78	101.02	100.66	101.13	0.004476	2.61	22.99	25.49	0.48
Reach-1	16	70.00	99.78	101.13	100.72	101.24	0.004257	2.72	25.72	25.67	0.48
Reach-1	16	80.00	99.78	101.23	100.78	101.35	0.004104	2.83	28.29	25.85	0.48
Reach-1	16	90.00	99.78	101.32	100.84	101.45	0.003999	2.93	30.72	26.01	0.48
Reach-1	16	100.00	99.78	101.41	100.89	101.55	0.003917	3.03	33.05	26.17	0.47
Reach-1	16	200.00	99.78	102.09	101.36	102.32	0.003788	3.87	55.96	70.37	0.49
Reach-1	16	500.00	99.78	103.01	102.71	103.28	0.003576	4.88	204.37	255.23	0.51
Reach-1	16	750.00	99.78	103.42	103.12	103.69	0.003433	5.24	327.83	339.43	0.51
Reach-1	16	1000.00	99.78	103.73	103.40	103.99	0.003340	5.49	442.38	397.00	0.51
Reach-1	16	1500.00	99.78	104.15	103.83	104.40	0.003289	5.87	608.93	397.00	0.52

Reach-1	15.8*	10.00	99.53	100.08	100.00	100.16	0.012462	2.19	4.57	14.54	0.69
Reach-1	15.8*	20.00	99.53	100.32	100.16	100.40	0.009269	2.33	8.58	19.82	0.62
Reach-1	15.8*	30.00	99.53	100.51	100.30	100.60	0.007031	2.36	12.71	23.40	0.56
Reach-1	15.8*	40.00	99.53	100.67	100.39	100.76	0.005678	2.39	16.75	25.73	0.52
Reach-1	15.8*	50.00	99.53	100.81	100.48	100.91	0.004720	2.46	20.35	25.97	0.49
Reach-1	15.8*	60.00	99.53	100.94	100.55	101.04	0.004205	2.54	23.63	26.18	0.47
Reach-1	15.8*	70.00	99.53	101.05	100.63	101.16	0.003915	2.63	26.60	26.37	0.46
Reach-1	15.8*	80.00	99.53	101.15	100.68	101.27	0.003733	2.72	29.36	26.55	0.46
Reach-1	15.8*	90.00	99.53	101.25	100.74	101.37	0.003616	2.82	31.93	26.72	0.45
Reach-1	15.8*	100.00	99.53	101.34	100.79	101.47	0.003529	2.91	34.39	26.87	0.45
Reach-1	15.8*	200.00	99.53	102.04	101.26	102.25	0.003406	3.72	58.51	73.34	0.47
Reach-1	15.8*	500.00	99.53	102.94	102.60	103.21	0.003324	4.75	208.69	257.35	0.50
Reach-1	15.8*	750.00	99.53	103.36	103.03	103.62	0.003242	5.13	332.48	341.16	0.50
Reach-1	15.8*	1000.00	99.53	103.67	103.31	103.92	0.003130	5.37	449.98	397.33	0.50
Reach-1	15.8*	1500.00	99.53	104.08	103.76	104.33	0.003169	5.81	613.47	397.33	0.51
Reach-1	15.6*	10.00	99.28	99.92	99.75	99.97	0.006971	1.90	5.26	13.27	0.53
Reach-1	15.6*	20.00	99.28	100.18	99.93	100.25	0.005728	2.18	9.16	16.17	0.51
Reach-1	15.6*	30.00	99.28	100.39	100.07	100.47	0.005515	2.34	12.81	19.77	0.51
Reach-1	15.6*	40.00	99.28	100.56	100.18	100.65	0.005010	2.41	16.62	22.88	0.50
Reach-1	15.6*	50.00	99.28	100.72	100.30	100.81	0.004566	2.45	20.37	25.36	0.48
Reach-1	15.6*	60.00	99.28	100.86	100.39	100.95	0.004138	2.50	23.96	26.83	0.47
Reach-1	15.6*	70.00	99.28	100.98	100.48	101.08	0.003732	2.57	27.23	27.04	0.45
Reach-1	15.6*	80.00	99.28	101.09	100.56	101.20	0.003502	2.65	30.20	27.22	0.44
Reach-1	15.6*	90.00	99.28	101.19	100.63	101.30	0.003364	2.73	32.93	27.39	0.44
Reach-1	15.6*	100.00	99.28	101.28	100.69	101.40	0.003266	2.82	35.52	27.54	0.44
Reach-1	15.6*	200.00	99.28	101.98	101.17	102.18	0.003138	3.60	60.50	74.92	0.45
Reach-1	15.6*	500.00	99.28	102.88	102.50	103.14	0.003180	4.66	210.18	257.32	0.49
Reach-1	15.6*	750.00	99.28	103.29	102.95	103.55	0.003151	5.08	332.90	340.43	0.50
Reach-1	15.6*	1000.00	99.28	103.60	103.24	103.85	0.003108	5.36	447.58	397.67	0.50
Reach-1	15.6*	1500.00	99.28	104.02	103.69	104.27	0.003138	5.79	612.38	397.67	0.51
Reach-1	15.4*	10.00	99.04	99.86	99.51	99.89	0.002447	1.38	7.25	13.41	0.33
Reach-1	15.4*	20.00	99.04	100.12	99.70	100.17	0.002979	1.82	11.00	15.53	0.38
Reach-1	15.4*	30.00	99.04	100.31	99.86	100.38	0.003296	2.11	14.20	17.22	0.41
Reach-1	15.4*	40.00	99.04	100.48	99.98	100.57	0.003684	2.30	17.42	20.24	0.44
Reach-1	15.4*	50.00	99.04	100.64	100.09	100.73	0.003756	2.41	20.73	22.70	0.44
Reach-1	15.4*	60.00	99.04	100.78	100.18	100.87	0.003738	2.50	24.04	24.91	0.45
Reach-1	15.4*	70.00	99.04	100.90	100.28	101.01	0.003658	2.56	27.31	26.73	0.45
Reach-1	15.4*	80.00	99.04	101.02	100.38	101.13	0.003522	2.63	30.43	27.83	0.44
Reach-1	15.4*	90.00	99.04	101.12	100.47	101.24	0.003332	2.70	33.34	28.02	0.44
Reach-1	15.4*	100.00	99.04	101.22	100.54	101.34	0.003202	2.77	36.06	28.19	0.43
Reach-1	15.4*	200.00	99.04	101.93	101.10	102.12	0.002992	3.51	62.47	78.59	0.44
Reach-1	15.4*	500.00	99.04	102.83	102.41	103.07	0.003018	4.55	215.35	260.46	0.47
Reach-1	15.4*	750.00	99.04	103.24	102.87	103.48	0.003013	4.97	338.73	342.92	0.49
Reach-1	15.4*	1000.00	99.04	103.54	103.16	103.79	0.002990	5.26	453.18	398.00	0.49
Reach-1	15.4*	1500.00	99.04	103.96	103.61	104.20	0.003048	5.71	617.53	398.00	0.50
Reach-1	15.2*	10.00	98.79	99.84	99.26	99.85	0.000968	1.03	9.69	13.66	0.22
Reach-1	15.2*	20.00	98.79	100.08	99.46	100.12	0.001585	1.51	13.28	15.30	0.28
Reach-1	15.2*	30.00	98.79	100.27	99.63	100.33	0.002007	1.84	16.29	16.50	0.33
Reach-1	15.2*	40.00	98.79	100.43	99.76	100.50	0.002425	2.10	19.05	18.26	0.36
Reach-1	15.2*	50.00	98.79	100.58	99.88	100.66	0.002805	2.28	21.89	20.63	0.39
Reach-1	15.2*	60.00	98.79	100.71	99.98	100.81	0.003020	2.42	24.79	22.66	0.41
Reach-1	15.2*	70.00	98.79	100.84	100.08	100.94	0.003155	2.53	27.70	24.53	0.42
Reach-1	15.2*	80.00	98.79	100.95	100.17	101.06	0.003247	2.62	30.56	26.23	0.43
Reach-1	15.2*	90.00	98.79	101.06	100.25	101.17	0.003275	2.69	33.40	27.61	0.43
Reach-1	15.2*	100.00	98.79	101.15	100.33	101.27	0.003265	2.76	36.19	28.73	0.43

Reach-1	15.2*	200.00	98.79	101.87	101.02	102.05	0.002943	3.46	63.58	80.47	0.44
Reach-1	15.2*	500.00	98.79	102.77	102.33	103.01	0.002937	4.46	218.66	263.27	0.47
Reach-1	15.2*	750.00	98.79	103.18	102.79	103.42	0.002934	4.88	343.16	346.05	0.48
Reach-1	15.2*	1000.00	98.79	103.49	103.08	103.72	0.002902	5.15	458.36	398.33	0.48
Reach-1	15.2*	1500.00	98.79	103.90	103.54	104.14	0.002980	5.62	622.19	398.33	0.50
Reach-1	15.*	10.00	98.54	99.83	99.01	99.84	0.000463	0.82	12.26	13.93	0.15
Reach-1	15.*	20.00	98.54	100.07	99.22	100.09	0.000912	1.27	15.77	15.26	0.22
Reach-1	15.*	30.00	98.54	100.25	99.39	100.29	0.001284	1.61	18.65	16.27	0.26
Reach-1	15.*	40.00	98.54	100.41	99.53	100.46	0.001593	1.88	21.22	17.13	0.30
Reach-1	15.*	50.00	98.54	100.54	99.65	100.61	0.001976	2.11	23.69	19.00	0.33
Reach-1	15.*	60.00	98.54	100.67	99.77	100.75	0.002294	2.29	26.22	20.86	0.36
Reach-1	15.*	70.00	98.54	100.79	99.87	100.88	0.002535	2.43	28.77	22.53	0.38
Reach-1	15.*	80.00	98.54	100.89	99.96	101.00	0.002730	2.56	31.29	24.06	0.40
Reach-1	15.*	90.00	98.54	101.00	100.05	101.11	0.002881	2.66	33.81	25.50	0.41
Reach-1	15.*	100.00	98.54	101.09	100.14	101.21	0.002997	2.75	36.33	26.87	0.42
Reach-1	15.*	200.00	98.54	101.81	100.87	101.99	0.002969	3.43	64.20	81.72	0.44
Reach-1	15.*	500.00	98.54	102.72	102.26	102.95	0.002903	4.40	220.92	264.80	0.46
Reach-1	15.*	750.00	98.54	103.13	102.72	103.36	0.002895	4.81	346.05	347.53	0.47
Reach-1	15.*	1000.00	98.54	103.43	103.01	103.66	0.002864	5.08	461.24	398.67	0.48
Reach-1	15.*	1500.00	98.54	103.84	103.47	104.08	0.002952	5.55	624.71	398.67	0.49
Reach-1	14.8	10.00	98.29	99.82	98.76	99.83	0.000263	0.68	14.70	14.07	0.12
Reach-1	14.8	20.00	98.29	100.06	98.98	100.08	0.000585	1.10	18.14	15.23	0.18
Reach-1	14.8	30.00	98.29	100.24	99.16	100.27	0.000886	1.43	20.92	16.10	0.22
Reach-1	14.8	40.00	98.29	100.39	99.31	100.43	0.001157	1.71	23.38	16.84	0.26
Reach-1	14.8	50.00	98.29	100.52	99.44	100.58	0.001426	1.95	25.63	17.71	0.29
Reach-1	14.8	60.00	98.29	100.64	99.56	100.71	0.001744	2.15	27.85	19.35	0.32
Reach-1	14.8	70.00	98.29	100.75	99.67	100.83	0.002024	2.33	30.09	20.87	0.34
Reach-1	14.8	80.00	98.29	100.85	99.77	100.94	0.002271	2.48	32.29	22.26	0.36
Reach-1	14.8	90.00	98.29	100.95	99.86	101.05	0.002483	2.61	34.51	23.58	0.38
Reach-1	14.8	100.00	98.29	101.04	99.95	101.15	0.002662	2.72	36.74	24.84	0.39
Reach-1	14.8	200.00	98.29	101.75	100.71	101.93	0.003120	3.44	64.43	84.02	0.44
Reach-1	14.8	500.00	98.29	102.67	102.20	102.88	0.002860	4.30	226.29	269.30	0.46
Reach-1	14.8	750.00	98.29	103.08	102.65	103.30	0.002821	4.68	353.97	352.37	0.46
Reach-1	14.8	1000.00	98.29	103.39	102.93	103.60	0.002759	4.92	471.01	399.00	0.46
Reach-1	14.8	1500.00	98.29	103.79	103.40	104.01	0.002873	5.41	633.27	399.00	0.48
Reach-1	14.6*	10.00	98.50	99.82	98.97	99.82	0.000404	0.77	13.02	14.67	0.14
Reach-1	14.6*	20.00	98.50	100.04	99.18	100.06	0.000834	1.21	16.47	16.01	0.21
Reach-1	14.6*	30.00	98.50	100.21	99.35	100.25	0.001213	1.56	19.25	17.01	0.26
Reach-1	14.6*	40.00	98.50	100.35	99.48	100.40	0.001651	1.84	21.79	18.98	0.30
Reach-1	14.6*	50.00	98.50	100.48	99.60	100.54	0.002041	2.06	24.28	20.89	0.34
Reach-1	14.6*	60.00	98.50	100.59	99.71	100.67	0.002349	2.24	26.76	22.55	0.36
Reach-1	14.6*	70.00	98.50	100.70	99.81	100.79	0.002594	2.39	29.26	24.10	0.38
Reach-1	14.6*	80.00	98.50	100.80	99.91	100.89	0.002795	2.52	31.71	25.53	0.40
Reach-1	14.6*	90.00	98.50	100.89	99.99	101.00	0.002949	2.63	34.19	26.89	0.41
Reach-1	14.6*	100.00	98.50	100.98	100.08	101.10	0.003059	2.73	36.69	28.16	0.42
Reach-1	14.6*	200.00	98.50	101.69	100.79	101.87	0.002886	3.42	64.82	83.31	0.43
Reach-1	14.6*	500.00	98.50	102.60	102.14	102.83	0.002808	4.36	224.73	267.77	0.46
Reach-1	14.6*	750.00	98.50	103.01	102.60	103.24	0.002851	4.80	348.41	348.99	0.47
Reach-1	14.6*	1000.00	98.50	103.31	102.88	103.54	0.002807	5.06	464.80	398.50	0.47
Reach-1	14.6*	1500.00	98.50	103.72	103.35	103.95	0.002910	5.54	627.76	398.50	0.49
Reach-1	14.4*	10.00	98.71	99.80	99.19	99.81	0.000723	0.90	11.11	15.57	0.19
Reach-1	14.4*	20.00	98.71	100.01	99.38	100.04	0.001382	1.37	14.57	17.55	0.27
Reach-1	14.4*	30.00	98.71	100.17	99.53	100.21	0.002030	1.71	17.55	20.32	0.32
Reach-1	14.4*	40.00	98.71	100.30	99.65	100.36	0.002501	1.96	20.39	22.43	0.36
Reach-1	14.4*	50.00	98.71	100.42	99.76	100.49	0.002852	2.16	23.14	24.31	0.39

Reach-1	14.4*	60.00	98.71	100.53	99.86	100.61	0.003080	2.31	25.92	25.99	0.41
Reach-1	14.4*	70.00	98.71	100.64	99.95	100.73	0.003200	2.44	28.72	27.43	0.42
Reach-1	14.4*	80.00	98.71	100.73	100.06	100.83	0.003163	2.54	31.47	27.90	0.42
Reach-1	14.4*	90.00	98.71	100.83	100.14	100.94	0.003095	2.64	34.12	28.06	0.42
Reach-1	14.4*	100.00	98.71	100.92	100.22	101.03	0.003039	2.73	36.66	28.22	0.42
Reach-1	14.4*	200.00	98.71	101.63	100.76	101.81	0.002839	3.45	64.64	83.89	0.43
Reach-1	14.4*	500.00	98.71	102.54	102.09	102.77	0.002806	4.42	224.67	267.55	0.46
Reach-1	14.4*	750.00	98.71	102.94	102.55	103.18	0.002880	4.88	346.75	347.59	0.48
Reach-1	14.4*	1000.00	98.71	103.25	102.83	103.48	0.002853	5.16	461.97	398.00	0.48
Reach-1	14.4*	1500.00	98.71	103.66	103.29	103.89	0.002940	5.63	625.71	398.00	0.50
Reach-1	14.2*	10.00	98.93	99.77	99.40	99.79	0.001868	1.14	8.75	17.71	0.29
Reach-1	14.2*	20.00	98.93	99.96	99.57	100.00	0.002942	1.60	12.51	21.42	0.37
Reach-1	14.2*	30.00	98.93	100.10	99.71	100.16	0.003570	1.90	15.76	24.00	0.41
Reach-1	14.2*	40.00	98.93	100.23	99.82	100.30	0.003822	2.12	18.88	25.74	0.44
Reach-1	14.2*	50.00	98.93	100.35	99.92	100.43	0.003782	2.28	21.90	26.40	0.44
Reach-1	14.2*	60.00	98.93	100.45	100.00	100.55	0.003652	2.42	24.80	26.58	0.44
Reach-1	14.2*	70.00	98.93	100.56	100.08	100.66	0.003532	2.54	27.59	26.76	0.44
Reach-1	14.2*	80.00	98.93	100.66	100.15	100.77	0.003433	2.64	30.26	26.93	0.44
Reach-1	14.2*	90.00	98.93	100.75	100.21	100.87	0.003348	2.74	32.85	27.09	0.44
Reach-1	14.2*	100.00	98.93	100.85	100.28	100.97	0.003279	2.83	35.33	27.24	0.44
Reach-1	14.2*	200.00	98.93	101.56	100.72	101.76	0.003085	3.59	61.80	80.15	0.45
Reach-1	14.2*	500.00	98.93	102.47	102.07	102.71	0.003005	4.57	219.39	265.05	0.47
Reach-1	14.2*	750.00	98.93	102.88	102.51	103.12	0.003011	4.99	343.17	346.96	0.49
Reach-1	14.2*	1000.00	98.93	103.18	102.80	103.42	0.002950	5.24	459.19	397.50	0.49
Reach-1	14.2*	1500.00	98.93	103.59	103.24	103.83	0.003028	5.71	622.18	397.50	0.50
Reach-1	14	10.00	99.14	99.66	99.57	99.71	0.011219	1.86	5.36	20.07	0.64
Reach-1	14	20.00	99.14	99.82	99.71	99.90	0.009683	2.19	9.12	23.89	0.63
Reach-1	14	30.00	99.14	99.97	99.81	100.06	0.007650	2.37	12.68	24.76	0.58
Reach-1	14	40.00	99.14	100.10	99.90	100.20	0.006456	2.51	15.95	25.00	0.55
Reach-1	14	50.00	99.14	100.22	99.95	100.33	0.005698	2.63	19.04	25.21	0.53
Reach-1	14	60.00	99.14	100.34	100.02	100.46	0.005158	2.73	21.99	25.42	0.52
Reach-1	14	70.00	99.14	100.45	100.08	100.58	0.004773	2.82	24.81	25.61	0.51
Reach-1	14	80.00	99.14	100.56	100.14	100.69	0.004503	2.91	27.48	25.79	0.50
Reach-1	14	90.00	99.14	100.65	100.20	100.79	0.004296	3.00	30.03	25.97	0.49
Reach-1	14	100.00	99.14	100.75	100.25	100.90	0.004141	3.08	32.47	26.13	0.49
Reach-1	14	200.00	99.14	101.46	100.72	101.69	0.003767	3.86	56.17	70.95	0.49
Reach-1	14	500.00	99.14	102.37	102.07	102.65	0.003512	4.84	206.58	256.98	0.51
Reach-1	14	750.00	99.14	102.79	102.48	103.06	0.003339	5.18	332.62	342.27	0.51
Reach-1	14	1000.00	99.14	103.11	102.76	103.36	0.003177	5.38	451.54	397.00	0.50
Reach-1	14	1500.00	99.14	103.53	103.19	103.77	0.003184	5.80	616.21	397.00	0.51
Reach-1	13.8*	10.00	98.89	99.40	99.33	99.47	0.012599	2.15	4.66	15.37	0.69
Reach-1	13.8*	20.00	98.89	99.63	99.48	99.71	0.008888	2.34	8.56	19.10	0.62
Reach-1	13.8*	30.00	98.89	99.82	99.60	99.91	0.007048	2.38	12.60	23.00	0.57
Reach-1	13.8*	40.00	98.89	99.99	99.70	100.08	0.005569	2.42	16.54	24.66	0.52
Reach-1	13.8*	50.00	98.89	100.13	99.79	100.23	0.004694	2.49	20.10	25.14	0.49
Reach-1	13.8*	60.00	98.89	100.26	99.87	100.36	0.004189	2.57	23.36	25.45	0.47
Reach-1	13.8*	70.00	98.89	100.38	99.94	100.49	0.003877	2.65	26.38	25.74	0.46
Reach-1	13.8*	80.00	98.89	100.48	100.00	100.60	0.003679	2.74	29.20	26.00	0.46
Reach-1	13.8*	90.00	98.89	100.59	100.06	100.71	0.003533	2.82	31.88	26.25	0.45
Reach-1	13.8*	100.00	98.89	100.68	100.11	100.82	0.003431	2.90	34.43	26.48	0.45
Reach-1	13.8*	200.00	98.89	101.40	100.59	101.61	0.003253	3.67	59.08	72.91	0.46
Reach-1	13.8*	500.00	98.89	102.31	101.96	102.57	0.003271	4.74	208.09	256.31	0.49
Reach-1	13.8*	750.00	98.89	102.72	102.40	102.99	0.003201	5.14	331.96	340.42	0.50
Reach-1	13.8*	1000.00	98.89	103.03	102.68	103.29	0.003138	5.40	447.32	397.33	0.50
Reach-1	13.8*	1500.00	98.89	103.45	103.12	103.70	0.003137	5.82	613.84	397.33	0.51

Reach-1	13.6*	10.00	98.65	99.26	99.08	99.30	0.005786	1.74	5.74	14.43	0.49
Reach-1	13.6*	20.00	98.65	99.52	99.24	99.58	0.004763	2.02	9.91	17.18	0.47
Reach-1	13.6*	30.00	98.65	99.72	99.38	99.80	0.004510	2.21	13.59	19.79	0.47
Reach-1	13.6*	40.00	98.65	99.89	99.49	99.98	0.004308	2.31	17.32	22.75	0.47
Reach-1	13.6*	50.00	98.65	100.05	99.59	100.14	0.003916	2.38	21.00	24.53	0.45
Reach-1	13.6*	60.00	98.65	100.19	99.68	100.28	0.003554	2.45	24.45	25.31	0.44
Reach-1	13.6*	70.00	98.65	100.31	99.77	100.41	0.003310	2.53	27.62	25.71	0.43
Reach-1	13.6*	80.00	98.65	100.42	99.85	100.53	0.003168	2.62	30.53	26.07	0.43
Reach-1	13.6*	90.00	98.65	100.53	99.92	100.64	0.003069	2.70	33.30	26.42	0.42
Reach-1	13.6*	100.00	98.65	100.63	99.98	100.75	0.003004	2.78	35.91	26.73	0.42
Reach-1	13.6*	200.00	98.65	101.35	100.48	101.55	0.002943	3.54	61.56	75.57	0.44
Reach-1	13.6*	500.00	98.65	102.25	101.85	102.51	0.003081	4.64	211.08	257.69	0.48
Reach-1	13.6*	750.00	98.65	102.66	102.31	102.92	0.003066	5.06	334.51	341.33	0.49
Reach-1	13.6*	1000.00	98.65	102.97	102.60	103.22	0.003066	5.37	447.45	397.67	0.50
Reach-1	13.6*	1500.00	98.65	103.39	103.06	103.64	0.003070	5.79	615.08	397.67	0.51
Reach-1	13.4*	10.00	98.40	99.21	98.83	99.23	0.001866	1.24	8.09	14.45	0.29
Reach-1	13.4*	20.00	98.40	99.47	99.01	99.51	0.002358	1.66	12.07	16.52	0.34
Reach-1	13.4*	30.00	98.40	99.66	99.15	99.72	0.002620	1.94	15.47	18.05	0.37
Reach-1	13.4*	40.00	98.40	99.83	99.27	99.90	0.002925	2.14	18.69	20.42	0.39
Reach-1	13.4*	50.00	98.40	99.99	99.38	100.07	0.003078	2.27	21.99	22.82	0.41
Reach-1	13.4*	60.00	98.40	100.13	99.48	100.21	0.003054	2.37	25.35	24.60	0.41
Reach-1	13.4*	70.00	98.40	100.25	99.57	100.35	0.002929	2.45	28.54	25.42	0.41
Reach-1	13.4*	80.00	98.40	100.37	99.65	100.47	0.002847	2.54	31.49	25.97	0.41
Reach-1	13.4*	90.00	98.40	100.48	99.73	100.58	0.002787	2.62	34.30	26.44	0.41
Reach-1	13.4*	100.00	98.40	100.57	99.82	100.69	0.002753	2.71	36.95	26.88	0.41
Reach-1	13.4*	200.00	98.40	101.30	100.38	101.49	0.002771	3.44	63.58	78.47	0.43
Reach-1	13.4*	500.00	98.40	102.19	101.75	102.44	0.002949	4.55	214.39	259.79	0.47
Reach-1	13.4*	750.00	98.40	102.60	102.23	102.86	0.002963	4.98	337.93	343.12	0.48
Reach-1	13.4*	1000.00	98.40	102.91	102.52	103.16	0.002940	5.27	453.02	398.00	0.49
Reach-1	13.4*	1500.00	98.40	103.33	102.99	103.58	0.003005	5.73	617.84	398.00	0.50
Reach-1	13.2*	10.00	98.16	99.19	98.60	99.21	0.000804	0.96	10.44	14.38	0.20
Reach-1	13.2*	20.00	98.16	99.44	98.79	99.47	0.001339	1.41	14.20	16.03	0.26
Reach-1	13.2*	30.00	98.16	99.63	98.94	99.68	0.001709	1.73	17.36	17.27	0.30
Reach-1	13.2*	40.00	98.16	99.79	99.07	99.85	0.002024	1.98	20.23	18.65	0.33
Reach-1	13.2*	50.00	98.16	99.94	99.18	100.01	0.002342	2.16	23.10	20.76	0.36
Reach-1	13.2*	60.00	98.16	100.07	99.29	100.16	0.002542	2.30	26.06	22.73	0.38
Reach-1	13.2*	70.00	98.16	100.20	99.38	100.29	0.002670	2.41	29.05	24.55	0.39
Reach-1	13.2*	80.00	98.16	100.32	99.47	100.41	0.002666	2.51	31.93	25.40	0.39
Reach-1	13.2*	90.00	98.16	100.42	99.56	100.53	0.002665	2.59	34.70	26.18	0.40
Reach-1	13.2*	100.00	98.16	100.52	99.64	100.63	0.002664	2.68	37.34	26.80	0.40
Reach-1	13.2*	200.00	98.16	101.25	100.30	101.43	0.002727	3.39	65.30	82.73	0.43
Reach-1	13.2*	500.00	98.16	102.15	101.68	102.38	0.002841	4.44	219.68	263.10	0.46
Reach-1	13.2*	750.00	98.16	102.55	102.15	102.79	0.002862	4.87	344.03	345.65	0.47
Reach-1	13.2*	1000.00	98.16	102.86	102.42	103.10	0.002849	5.16	458.93	398.33	0.48
Reach-1	13.2*	1500.00	98.16	103.27	102.92	103.51	0.002937	5.63	623.01	398.33	0.50
Reach-1	13.*	10.00	97.92	99.19	98.36	99.20	0.000434	0.79	12.59	14.24	0.15
Reach-1	13.*	20.00	97.92	99.42	98.57	99.45	0.000857	1.24	16.16	15.59	0.21
Reach-1	13.*	30.00	97.92	99.61	98.73	99.65	0.001204	1.57	19.11	16.60	0.26
Reach-1	13.*	40.00	97.92	99.76	98.87	99.82	0.001492	1.84	21.75	17.46	0.29
Reach-1	13.*	50.00	97.92	99.90	98.99	99.97	0.001813	2.06	24.25	18.98	0.32
Reach-1	13.*	60.00	97.92	100.03	99.11	100.11	0.002099	2.24	26.83	20.79	0.35
Reach-1	13.*	70.00	97.92	100.15	99.21	100.24	0.002319	2.38	29.45	22.47	0.37
Reach-1	13.*	80.00	97.92	100.26	99.30	100.36	0.002493	2.50	32.06	24.02	0.38
Reach-1	13.*	90.00	97.92	100.37	99.39	100.47	0.002601	2.60	34.66	25.27	0.39
Reach-1	13.*	100.00	97.92	100.47	99.47	100.58	0.002664	2.69	37.20	26.20	0.40
Reach-1	13.*	200.00	97.92	101.20	100.20	101.37	0.002827	3.38	65.62	84.47	0.43

Reach-1	13.*	500.00	97.92	102.09	101.62	102.32	0.002839	4.37	222.42	265.73	0.46
Reach-1	13.*	750.00	97.92	102.50	102.09	102.73	0.002836	4.79	348.22	348.62	0.47
Reach-1	13.*	1000.00	97.92	102.81	102.38	103.04	0.002802	5.05	464.12	398.67	0.47
Reach-1	13.*	1500.00	97.92	103.22	102.85	103.45	0.002902	5.53	627.51	398.67	0.49
Reach-1	12.8	10.00	97.67	99.18	98.14	99.19	0.000281	0.70	14.37	13.95	0.12
Reach-1	12.8	20.00	97.67	99.41	98.37	99.43	0.000621	1.13	17.76	15.10	0.18
Reach-1	12.8	30.00	97.67	99.59	98.54	99.62	0.000936	1.46	20.51	15.98	0.23
Reach-1	12.8	40.00	97.67	99.74	98.69	99.79	0.001218	1.74	22.95	16.71	0.26
Reach-1	12.8	50.00	97.67	99.87	98.82	99.93	0.001472	1.98	25.20	17.38	0.29
Reach-1	12.8	60.00	97.67	99.99	98.94	100.07	0.001798	2.19	27.43	19.05	0.32
Reach-1	12.8	70.00	97.67	100.11	99.05	100.20	0.002079	2.36	29.71	20.62	0.35
Reach-1	12.8	80.00	97.67	100.22	99.15	100.31	0.002321	2.50	31.98	22.06	0.37
Reach-1	12.8	90.00	97.67	100.32	99.24	100.42	0.002525	2.63	34.25	23.43	0.38
Reach-1	12.8	100.00	97.67	100.41	99.33	100.53	0.002698	2.74	36.52	24.72	0.40
Reach-1	12.8	200.00	97.67	101.13	100.09	101.31	0.003124	3.44	64.37	83.89	0.45
Reach-1	12.8	500.00	97.67	102.04	101.58	102.26	0.002925	4.34	223.41	267.13	0.46
Reach-1	12.8	750.00	97.67	102.45	102.03	102.67	0.002870	4.71	350.88	350.59	0.47
Reach-1	12.8	1000.00	97.67	102.76	102.31	102.97	0.002806	4.96	467.81	399.00	0.47
Reach-1	12.8	1500.00	97.67	103.17	102.78	103.39	0.002904	5.43	630.76	399.00	0.49
Reach-1	12.6*	10.00	97.88	99.17	98.32	99.18	0.000360	0.73	13.63	15.19	0.14
Reach-1	12.6*	20.00	97.88	99.40	98.52	99.42	0.000746	1.16	17.20	16.52	0.20
Reach-1	12.6*	30.00	97.88	99.57	98.68	99.60	0.001083	1.49	20.10	17.54	0.25
Reach-1	12.6*	40.00	97.88	99.71	98.81	99.76	0.001436	1.76	22.70	19.09	0.28
Reach-1	12.6*	50.00	97.88	99.84	98.93	99.90	0.001776	1.98	25.26	20.92	0.32
Reach-1	12.6*	60.00	97.88	99.96	99.04	100.03	0.002054	2.16	27.82	22.62	0.34
Reach-1	12.6*	70.00	97.88	100.07	99.14	100.15	0.002272	2.30	30.41	24.21	0.36
Reach-1	12.6*	80.00	97.88	100.17	99.23	100.26	0.002394	2.42	32.99	25.26	0.37
Reach-1	12.6*	90.00	97.88	100.27	99.31	100.37	0.002472	2.53	35.51	26.05	0.38
Reach-1	12.6*	100.00	97.88	100.36	99.40	100.47	0.002537	2.63	37.96	26.78	0.39
Reach-1	12.6*	200.00	97.88	101.08	100.10	101.25	0.002719	3.36	66.02	84.52	0.42
Reach-1	12.6*	500.00	97.88	101.98	101.49	102.20	0.002779	4.37	223.45	266.61	0.46
Reach-1	12.6*	750.00	97.88	102.38	101.97	102.61	0.002839	4.83	346.49	347.92	0.47
Reach-1	12.6*	1000.00	97.88	102.68	102.26	102.91	0.002808	5.10	462.37	398.50	0.48
Reach-1	12.6*	1500.00	97.88	103.09	102.73	103.33	0.002909	5.58	625.79	398.50	0.49
Reach-1	12.4*	10.00	98.09	99.16	98.52	99.17	0.000573	0.82	12.20	16.60	0.17
Reach-1	12.4*	20.00	98.09	99.38	98.70	99.40	0.001071	1.25	15.95	18.30	0.24
Reach-1	12.4*	30.00	98.09	99.54	98.84	99.58	0.001561	1.57	19.12	20.78	0.29
Reach-1	12.4*	40.00	98.09	99.68	98.96	99.73	0.001942	1.81	22.11	22.88	0.32
Reach-1	12.4*	50.00	98.09	99.80	99.07	99.86	0.002198	2.00	25.04	24.50	0.35
Reach-1	12.4*	60.00	98.09	99.91	99.16	99.99	0.002298	2.15	27.90	25.24	0.36
Reach-1	12.4*	70.00	98.09	100.02	99.25	100.10	0.002357	2.28	30.68	25.83	0.37
Reach-1	12.4*	80.00	98.09	100.13	99.33	100.21	0.002394	2.40	33.35	26.28	0.38
Reach-1	12.4*	90.00	98.09	100.22	99.42	100.32	0.002423	2.50	35.93	26.71	0.38
Reach-1	12.4*	100.00	98.09	100.31	99.50	100.42	0.002453	2.60	38.41	27.12	0.39
Reach-1	12.4*	200.00	98.09	101.03	100.06	101.20	0.002581	3.36	66.90	86.93	0.42
Reach-1	12.4*	500.00	98.09	101.92	101.44	102.15	0.002726	4.41	224.90	267.65	0.46
Reach-1	12.4*	750.00	98.09	102.31	101.91	102.55	0.002836	4.89	345.96	347.46	0.47
Reach-1	12.4*	1000.00	98.09	102.62	102.20	102.85	0.002815	5.17	461.49	398.00	0.48
Reach-1	12.4*	1500.00	98.09	103.03	102.67	103.27	0.002911	5.65	625.36	398.00	0.50
Reach-1	12.2*	10.00	98.30	99.14	98.73	99.16	0.001287	1.01	9.93	18.35	0.24
Reach-1	12.2*	20.00	98.30	99.34	98.89	99.37	0.002107	1.43	13.97	22.04	0.32
Reach-1	12.2*	30.00	98.30	99.49	99.01	99.54	0.002523	1.71	17.52	24.18	0.35
Reach-1	12.2*	40.00	98.30	99.62	99.12	99.68	0.002676	1.93	20.76	25.05	0.37
Reach-1	12.2*	50.00	98.30	99.74	99.22	99.81	0.002725	2.10	23.77	25.38	0.38
Reach-1	12.2*	60.00	98.30	99.86	99.31	99.94	0.002729	2.25	26.68	25.70	0.39

Reach-1	12.2*	70.00	98.30	99.96	99.39	100.05	0.002719	2.37	29.48	26.00	0.39
Reach-1	12.2*	80.00	98.30	100.07	99.46	100.16	0.002711	2.49	32.15	26.29	0.40
Reach-1	12.2*	90.00	98.30	100.16	99.52	100.27	0.002704	2.59	34.72	26.56	0.40
Reach-1	12.2*	100.00	98.30	100.26	99.58	100.37	0.002707	2.69	37.15	26.81	0.40
Reach-1	12.2*	200.00	98.30	100.96	100.05	101.14	0.002788	3.49	64.48	84.59	0.43
Reach-1	12.2*	500.00	98.30	101.85	101.43	102.09	0.002936	4.56	219.25	264.59	0.47
Reach-1	12.2*	750.00	98.30	102.25	101.88	102.49	0.002985	5.01	341.55	345.94	0.49
Reach-1	12.2*	1000.00	98.30	102.55	102.17	102.80	0.002935	5.27	457.51	397.50	0.49
Reach-1	12.2*	1500.00	98.30	102.96	102.62	103.21	0.003021	5.74	620.38	397.50	0.50
Reach-1	12	10.00	98.51	99.05	98.94	99.10	0.008528	1.69	5.93	20.97	0.56
Reach-1	12	20.00	98.51	99.24	99.08	99.30	0.006974	1.97	10.15	24.45	0.54
Reach-1	12	30.00	98.51	99.39	99.18	99.46	0.005648	2.15	13.92	24.85	0.51
Reach-1	12	40.00	98.51	99.52	99.27	99.61	0.005014	2.32	17.25	25.09	0.49
Reach-1	12	50.00	98.51	99.65	99.32	99.74	0.004620	2.46	20.32	25.30	0.48
Reach-1	12	60.00	98.51	99.76	99.39	99.87	0.004292	2.58	23.29	25.51	0.48
Reach-1	12	70.00	98.51	99.87	99.45	99.98	0.004046	2.68	26.13	25.70	0.47
Reach-1	12	80.00	98.51	99.98	99.51	100.10	0.003872	2.78	28.81	25.89	0.46
Reach-1	12	90.00	98.51	100.08	99.57	100.20	0.003743	2.87	31.37	26.06	0.46
Reach-1	12	100.00	98.51	100.17	99.62	100.30	0.003662	2.96	33.76	26.22	0.46
Reach-1	12	200.00	98.51	100.86	100.10	101.08	0.003536	3.78	58.58	77.55	0.48
Reach-1	12	500.00	98.51	101.76	101.44	102.03	0.003373	4.77	211.55	260.86	0.50
Reach-1	12	750.00	98.51	102.18	101.85	102.43	0.003237	5.12	338.01	345.45	0.50
Reach-1	12	1000.00	98.51	102.50	102.13	102.74	0.003087	5.32	456.82	397.00	0.50
Reach-1	12	1500.00	98.51	102.91	102.56	103.15	0.003133	5.76	619.85	397.00	0.51
Reach-1	11.8*	10.00	98.27	98.82	98.73	98.90	0.011683	2.14	4.68	14.70	0.67
Reach-1	11.8*	20.00	98.27	99.06	98.90	99.14	0.008660	2.28	8.78	19.94	0.61
Reach-1	11.8*	30.00	98.27	99.26	99.03	99.34	0.006619	2.30	13.02	23.72	0.55
Reach-1	11.8*	40.00	98.27	99.42	99.13	99.50	0.005448	2.36	16.96	25.73	0.51
Reach-1	11.8*	50.00	98.27	99.55	99.21	99.65	0.004571	2.43	20.55	25.97	0.48
Reach-1	11.8*	60.00	98.27	99.68	99.29	99.78	0.004063	2.51	23.88	26.19	0.46
Reach-1	11.8*	70.00	98.27	99.80	99.36	99.90	0.003742	2.59	26.98	26.39	0.45
Reach-1	11.8*	80.00	98.27	99.91	99.42	100.02	0.003536	2.68	29.86	26.58	0.45
Reach-1	11.8*	90.00	98.27	100.01	99.47	100.13	0.003393	2.76	32.57	26.75	0.44
Reach-1	11.8*	100.00	98.27	100.10	99.53	100.23	0.003308	2.85	35.09	26.91	0.44
Reach-1	11.8*	200.00	98.27	100.80	99.99	101.01	0.003200	3.64	60.81	79.12	0.46
Reach-1	11.8*	500.00	98.27	101.70	101.34	101.96	0.003202	4.68	213.01	260.64	0.49
Reach-1	11.8*	750.00	98.27	102.11	101.78	102.37	0.003124	5.06	338.63	344.72	0.49
Reach-1	11.8*	1000.00	98.27	102.43	102.05	102.67	0.003028	5.30	455.88	397.33	0.49
Reach-1	11.8*	1500.00	98.27	102.84	102.50	103.08	0.003087	5.75	619.20	397.33	0.51
Reach-1	11.6*	10.00	98.02	98.67	98.49	98.72	0.006373	1.84	5.42	13.42	0.51
Reach-1	11.6*	20.00	98.02	98.94	98.67	99.01	0.005294	2.13	9.41	16.32	0.49
Reach-1	11.6*	30.00	98.02	99.14	98.81	99.22	0.005197	2.29	13.11	20.03	0.50
Reach-1	11.6*	40.00	98.02	99.31	98.92	99.40	0.004911	2.39	16.75	22.98	0.49
Reach-1	11.6*	50.00	98.02	99.46	99.04	99.56	0.004504	2.44	20.47	25.41	0.48
Reach-1	11.6*	60.00	98.02	99.60	99.13	99.70	0.004041	2.49	24.13	26.84	0.46
Reach-1	11.6*	70.00	98.02	99.73	99.22	99.83	0.003590	2.54	27.56	27.06	0.44
Reach-1	11.6*	80.00	98.02	99.84	99.30	99.95	0.003333	2.61	30.67	27.25	0.43
Reach-1	11.6*	90.00	98.02	99.95	99.37	100.06	0.003166	2.68	33.56	27.42	0.43
Reach-1	11.6*	100.00	98.02	100.05	99.43	100.16	0.003071	2.76	36.21	27.59	0.42
Reach-1	11.6*	200.00	98.02	100.75	99.91	100.94	0.002952	3.53	62.99	81.39	0.44
Reach-1	11.6*	500.00	98.02	101.64	101.24	101.89	0.003054	4.59	215.30	261.31	0.48
Reach-1	11.6*	750.00	98.02	102.05	101.69	102.30	0.003017	4.99	340.61	344.98	0.49
Reach-1	11.6*	1000.00	98.02	102.36	101.98	102.60	0.002970	5.26	456.10	397.67	0.49
Reach-1	11.6*	1500.00	98.02	102.77	102.43	103.02	0.003041	5.72	619.57	397.67	0.50
Reach-1	11.4*	10.00	97.78	98.61	98.26	98.64	0.002302	1.35	7.40	13.47	0.32

Reach-1	11.4*	20.00	97.78	98.88	98.45	98.92	0.002823	1.78	11.21	15.64	0.37
Reach-1	11.4*	30.00	97.78	99.07	98.60	99.14	0.003205	2.08	14.41	17.48	0.40
Reach-1	11.4*	40.00	97.78	99.23	98.72	99.31	0.003664	2.30	17.42	20.18	0.44
Reach-1	11.4*	50.00	97.78	99.38	98.83	99.47	0.003782	2.42	20.67	22.66	0.45
Reach-1	11.4*	60.00	97.78	99.52	98.93	99.62	0.003743	2.49	24.06	24.99	0.45
Reach-1	11.4*	70.00	97.78	99.66	99.02	99.76	0.003579	2.54	27.53	26.84	0.44
Reach-1	11.4*	80.00	97.78	99.78	99.12	99.88	0.003373	2.59	30.84	27.85	0.43
Reach-1	11.4*	90.00	97.78	99.89	99.21	100.00	0.003149	2.65	33.93	28.05	0.43
Reach-1	11.4*	100.00	97.78	99.99	99.29	100.10	0.003024	2.72	36.72	28.22	0.42
Reach-1	11.4*	200.00	97.78	100.70	99.84	100.88	0.002834	3.45	64.62	83.80	0.43
Reach-1	11.4*	500.00	97.78	101.59	101.16	101.82	0.002951	4.51	218.26	263.31	0.47
Reach-1	11.4*	750.00	97.78	102.00	101.61	102.24	0.002926	4.91	344.24	347.02	0.48
Reach-1	11.4*	1000.00	97.78	102.31	101.90	102.54	0.002886	5.18	459.93	398.00	0.48
Reach-1	11.4*	1500.00	97.78	102.71	102.36	102.96	0.002980	5.66	622.72	398.00	0.50
Reach-1	11.2*	10.00	97.54	98.59	98.01	98.61	0.000942	1.02	9.78	13.71	0.21
Reach-1	11.2*	20.00	97.54	98.84	98.21	98.88	0.001533	1.49	13.44	15.36	0.28
Reach-1	11.2*	30.00	97.54	99.03	98.38	99.08	0.001964	1.83	16.41	16.54	0.32
Reach-1	11.2*	40.00	97.54	99.18	98.51	99.25	0.002449	2.11	18.96	18.18	0.36
Reach-1	11.2*	50.00	97.54	99.32	98.63	99.40	0.002853	2.30	21.72	20.50	0.39
Reach-1	11.2*	60.00	97.54	99.46	98.73	99.55	0.003052	2.43	24.68	22.59	0.41
Reach-1	11.2*	70.00	97.54	99.59	98.83	99.69	0.003128	2.52	27.80	24.59	0.42
Reach-1	11.2*	80.00	97.54	99.71	98.92	99.82	0.003166	2.59	30.88	26.41	0.42
Reach-1	11.2*	90.00	97.54	99.83	99.00	99.93	0.003143	2.65	33.94	27.87	0.42
Reach-1	11.2*	100.00	97.54	99.93	99.08	100.04	0.003090	2.72	36.82	28.77	0.42
Reach-1	11.2*	200.00	97.54	100.65	99.77	100.83	0.002791	3.40	65.85	85.99	0.43
Reach-1	11.2*	500.00	97.54	101.53	101.08	101.76	0.002888	4.43	220.84	264.94	0.46
Reach-1	11.2*	750.00	97.54	101.94	101.54	102.18	0.002865	4.83	347.45	348.56	0.47
Reach-1	11.2*	1000.00	97.54	102.25	101.83	102.48	0.002830	5.10	463.14	398.33	0.48
Reach-1	11.2*	1500.00	97.54	102.66	102.29	102.89	0.002942	5.59	625.15	398.33	0.49
Reach-1	11.*	10.00	97.29	98.59	97.76	98.60	0.000459	0.81	12.31	13.96	0.15
Reach-1	11.*	20.00	97.29	98.83	97.97	98.85	0.000896	1.26	15.87	15.29	0.22
Reach-1	11.*	30.00	97.29	99.01	98.14	99.05	0.001271	1.60	18.71	16.28	0.26
Reach-1	11.*	40.00	97.29	99.15	98.29	99.21	0.001625	1.90	21.06	17.05	0.30
Reach-1	11.*	50.00	97.29	99.28	98.41	99.35	0.002012	2.13	23.44	18.73	0.34
Reach-1	11.*	60.00	97.29	99.41	98.52	99.50	0.002328	2.31	25.99	20.63	0.36
Reach-1	11.*	70.00	97.29	99.54	98.62	99.63	0.002539	2.44	28.73	22.48	0.38
Reach-1	11.*	80.00	97.29	99.66	98.72	99.76	0.002698	2.54	31.45	24.17	0.39
Reach-1	11.*	90.00	97.29	99.77	98.81	99.87	0.002809	2.63	34.20	25.76	0.40
Reach-1	11.*	100.00	97.29	99.87	98.89	99.98	0.002907	2.71	36.85	27.20	0.41
Reach-1	11.*	200.00	97.29	100.59	99.63	100.77	0.002819	3.37	66.63	87.83	0.43
Reach-1	11.*	500.00	97.29	101.48	101.01	101.70	0.002860	4.37	223.24	266.68	0.46
Reach-1	11.*	750.00	97.29	101.89	101.48	102.12	0.002824	4.76	350.91	350.43	0.47
Reach-1	11.*	1000.00	97.29	102.20	101.76	102.42	0.002785	5.02	466.92	398.67	0.47
Reach-1	11.*	1500.00	97.29	102.60	102.23	102.83	0.002913	5.52	628.03	398.67	0.49
Reach-1	10.8	10.00	97.05	98.58	97.52	98.59	0.000266	0.68	14.66	14.05	0.12
Reach-1	10.8	20.00	97.05	98.82	97.75	98.84	0.000585	1.10	18.14	15.23	0.18
Reach-1	10.8	30.00	97.05	98.99	97.92	99.03	0.000891	1.44	20.88	16.09	0.22
Reach-1	10.8	40.00	97.05	99.13	98.07	99.18	0.001196	1.73	23.10	16.76	0.26
Reach-1	10.8	50.00	97.05	99.26	98.20	99.32	0.001463	1.98	25.28	17.44	0.29
Reach-1	10.8	60.00	97.05	99.38	98.32	99.45	0.001786	2.18	27.53	19.12	0.32
Reach-1	10.8	70.00	97.05	99.50	98.43	99.59	0.002045	2.34	29.94	20.77	0.34
Reach-1	10.8	80.00	97.05	99.61	98.53	99.71	0.002264	2.47	32.34	22.29	0.36
Reach-1	10.8	90.00	97.05	99.72	98.62	99.82	0.002441	2.59	34.77	23.73	0.38
Reach-1	10.8	100.00	97.05	99.81	98.71	99.93	0.002602	2.69	37.11	25.04	0.39
Reach-1	10.8	200.00	97.05	100.53	99.47	100.71	0.002984	3.39	66.32	88.46	0.44
Reach-1	10.8	500.00	97.05	101.42	100.96	101.64	0.002891	4.32	224.89	268.25	0.46

Reach-1	10.8	750.00	97.05	101.84	101.41	102.06	0.002818	4.68	354.20	352.50	0.46
Reach-1	10.8	1000.00	97.05	102.15	101.69	102.36	0.002758	4.92	471.09	399.00	0.46
Reach-1	10.8	1500.00	97.05	102.55	102.16	102.77	0.002900	5.43	631.13	399.00	0.49
Reach-1	10.6*	10.00	97.26	98.57	97.73	98.58	0.000408	0.77	12.97	14.66	0.14
Reach-1	10.6*	20.00	97.26	98.80	97.94	98.82	0.000833	1.21	16.47	16.01	0.21
Reach-1	10.6*	30.00	97.26	98.97	98.11	99.00	0.001221	1,56	19.21	16.99	0.26
Reach-1	10.6*	40.00	97.26	99.09	98.24	99.15	0.001707	1.87	21.45	18.70	0.31
Reach-1	10.6*	50.00	97.26	99.21	98.36	99.28	0.002129	2.10	23.82	20.56	0.34
Reach-1	10.6*	60.00	97.26	99.33	98.47	99.41	0.002439	2.28	26.33	22.27	0.37
Reach-1	10.6*	70.00	97.26	99.45	98.57	99.54	0.002635	2.41	29.06	23.98	0.39
Reach-1	10.6*	80.00	97.26	99.56	98.67	99.66	0.002782	2.52	31.77	25.56	0.40
Reach-1	10.6*	90.00	97.26	99.66	98.75	99.77	0.002877	2.61	34.54	27.07	0.41
Reach-1	10.6*	100.00	97.26	99.76	98.84	99.87	0.002962	2.69	37.17	28.39	0.41
Reach-1	10.6*	200.00	97.26	100.48	99.54	100.65	0.002748	3.36	66.98	88.40	0.42
Reach-1	10.6*	500.00	97.26	101.36	100.90	101.58	0.002845	4.39	223.02	266.47	0.46
Reach-1	10.6*	750.00	97.26	101.77	101.36	102.00	0.002843	4.80	348.92	349.28	0.47
Reach-1	10.6*	1000.00	97.26	102.07	101.64	102.30	0.002806	5.06	464.84	398.50	0.47
Reach-1	10.6*	1500.00	97.26	102.47	102.11	102.71	0.002945	5.57	625.02	398.50	0.49
Reach-1	10.4*	10.00	97.48	98.56	97.95	98.57	0.000741	0.91	11.02	15.54	0.19
Reach-1	10.4*	20.00	97.48	98.77	98.14	98.80	0.001392	1.38	14.53	17.55	0.27
Reach-1	10.4*	30.00	97.48	98.93	98.29	98.97	0.002064	1.72	17.45	20.26	0.33
Reach-1	10.4*	40.00	97.48	99.04	98.41	99.10	0.002669	2.01	19.87	22.08	0.37
Reach-1	10.4*	50.00	97.48	99.15	98.52	99.23	0.003079	2.23	22.46	23.87	0.40
Reach-1	10.4*	60.00	97.48	99.27	98.62	99.35	0.003297	2.37	25.27	25.66	0.42
Reach-1	10.4*	70.00	97.48	99.38	98.71	99.48	0.003299	2.46	28.40	27.28	0.43
Reach-1	10.4*	80.00	97.48	99.50	98.82	99.60	0.003154	2.54	31.50	27.90	0.42
Reach-1	10.4*	90.00	97.48	99.60	98.91	99.71	0.002988	2.61	34.49	28.08	0.41
Reach-1	10.4*	100.00	97.48	99.70	98.99	99.81	0.002908	2.69	37.17	28.25	0.41
Reach-1	10.4*	200.00	97.48	100.42	99.53	100.60	0.002708	3.40	66.43	87.75	0.42
Reach-1	10.4*	500.00	97.48	101.29	100.85	101.53	0.002920	4.49	219.24	263.95	0.47
Reach-1	10.4*	750.00	97.48	101.70	101.31	101.94	0.002935	4.92	343.31	346.39	0.48
Reach-1	10.4*	1000.00	97.48	102.00	101.60	102.24	0.002931	5.21	456.69	398.00	0.49
Reach-1	10.4*	1500.00	97.48	102.40	102.06	102.65	0.003035	5.70	618.31	398.00	0.50
Reach-1	10.2*	10.00	97.69	98.53	98.16	98.55	0.001909	1.15	8.68	17.61	0.29
Reach-1	10.2*	20.00	97.69	98.72	98.33	98.76	0.002940	1.60	12.51	21.42	0.37
Reach-1	10.2*	30.00	97.69	98.86	98.47	98.92	0.003639	1.92	15.65	23.92	0.42
Reach-1	10.2*	40.00	97.69	98.96	98.58	99.04	0.004308	2.21	18.10	25.33	0.46
Reach-1	10.2*	50.00	97.69	99.07	98.68	99.16	0.004410	2.39	20.88	26.34	0.47
Reach-1	10.2*	60.00	97.69	99.18	98.76	99.28	0.004095	2.51	23.93	26.53	0.47
Reach-1	10.2*	70.00	97.69	99.31	98.84	99.41	0.003685	2.57	27.23	26.74	0.45
Reach-1	10.2*	80.00	97.69	99.42	98.91	99.53	0.003402	2.64	30.35	26.93	0.44
Reach-1	10.2*	90.00	97.69	99.53	98.97	99.65	0.003187	2.70	33.36	27.12	0.43
Reach-1	10.2*	100.00	97.69	99.63	99.04	99.75	0.003092	2.78	36.00	27.28	0.43
Reach-1	10.2*	200.00	97.69	100.35	99.48	100.54	0.002889	3.51	64.65	87.06	0.44
Reach-1	10.2*	500.00	97.69	101.22	100.83	101.47	0.003086	4.61	215.96	262.41	0.48
Reach-1	10.2*	750.00	97.69	101.63	101.27	101.88	0.003062	5.02	340.18	345.21	0.49
Reach-1	10.2*	1000.00	97.69	101.92	101.56	102.17	0.003064	5.32	452.03	397.50	0.50
Reach-1	10.2*	1500.00	97.69	102.34	102.00	102.59	0.003101	5.76	616.73	397.50	0.51
Reach-1	10	10.00	97.90	98.33	98.33	98.44	0.030346	2.67	3.74	17.19	1.01
Reach-1	10	20.00	97.90	98.47	98.47	98.62	0.026839	3.09	6.47	21.81	1.00
Reach-1	10	30.00	97.90	98.57	98.57	98.75	0.024837	3.43	8.73	23.68	1.00
Reach-1	10	40.00	97.90	98.70	98.66	98.87	0.016564	3.35	11.94	24.71	0.85
Reach-1	10	50.00	97.90	98.89	98.71	99.03	0.008758	3.00	16.66	25.05	0.65
Reach-1	10	60.00	97.90	99.04	98.78	99.17	0.006526	2.94	20.44	25.31	0.58
Reach-1	10	70.00	97.90	99.19	98.84	99.32	0.005130	2.89	24.26	25.57	0.52

Reach-1	10	80.00	97.90	99.32	98.90	99.45	0.004440	2.90	27.60	25.80	0.49
Reach-1	10	90.00	97.90	99.44	98.96	99.57	0.004004	2.93	30.71	26.01	0.48
Reach-1	10	100.00	97.90	99.54	99.01	99.68	0.003819	3.00	33.32	26.19	0.47
Reach-1	10	200.00	97.90	100.26	99.48	100.48	0.003463	3.76	59.42	79.72	0.47
Reach-1	10	500.00	97.90	101.10	100.83	101.39	0.003774	4.98	197.93	250.06	0.53
Reach-1	10	750.00	97.90	101.53	101.24	101.80	0.003507	5.28	324.20	337.25	0.52
Reach-1	10	1000.00	97.90	101.83	101.52	102.10	0.003478	5.58	434.46	395.00	0.52
Reach-1	10	1500.00	97.90	102.27	101.95	102.52	0.003286	5.87	609.11	397.00	0.52

Design Channel: Bankfull Discharge = 150 cfs; Slope = 0.0036 ft/ft

Profile Output Table - Standard Table 1
HEC-RAS Plan: ql50s361 River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 639
Plans = 1
Profiles = 15

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	20	10.00	101.50	102.06	101.95	102.11	0.009254	1.77	5.66	19.87	0.58
Reach-1	20	20.00	101.50	102.24	102.09	102.31	0.007992	2.08	9.62	23.61	0.57
Reach-1	20	30.00	101.50	102.38	102.20	102.46	0.006910	2.33	12.90	23.86	0.56
Reach-1	20	40.00	101.50	102.50	102.27	102.60	0.006257	2.52	15.89	24.07	0.55
Reach-1	20	50.00	101.50	102.61	102.34	102.72	0.005978	2.70	18.50	24.26	0.55
Reach-1	20	60.00	101.50	102.72	102.41	102.84	0.005632	2.84	21.12	24.45	0.54
Reach-1	20	70.00	101.50	102.82	102.48	102.95	0.005423	2.97	23.53	24.62	0.54
Reach-1	20	80.00	101.50	102.91	102.54	103.06	0.005254	3.10	25.84	24.79	0.53
Reach-1	20	90.00	101.50	103.00	102.60	103.16	0.005148	3.21	28.01	24.94	0.53
Reach-1	20	100.00	101.50	103.08	102.65	103.25	0.005058	3.32	30.11	25.09	0.53
Reach-1	20	200.00	101.50	103.74	103.14	104.02	0.004860	4.23	49.19	54.98	0.55
Reach-1	20	500.00	101.50	104.67	104.48	105.00	0.004381	5.29	186.28	242.12	0.56
Reach-1	20	750.00	101.50	105.09	104.88	105.40	0.004066	5.60	306.09	327.43	0.56
Reach-1	20	1000.00	101.50	105.40	105.14	105.69	0.003921	5.86	417.28	390.26	0.55
Reach-1	20	1500.00	101.50	105.82	105.56	106.09	0.003774	6.20	583.14	396.00	0.55
Reach-1	19.8*	10.00	101.25	101.80	101.72	101.88	0.013166	2.25	4.45	14.16	0.71
Reach-1	19.8*	20.00	101.25	102.01	101.89	102.11	0.011162	2.55	7.85	18.22	0.68
Reach-1	19.8*	30.00	101.25	102.20	102.02	102.30	0.009016	2.61	11.50	21.91	0.63
Reach-1	19.8*	40.00	101.25	102.36	102.12	102.46	0.007442	2.62	15.28	25.05	0.59
Reach-1	19.8*	50.00	101.25	102.49	102.21	102.60	0.006107	2.68	18.64	25.27	0.55
Reach-1	19.8*	60.00	101.25	102.61	102.30	102.73	0.005359	2.76	21.74	25.48	0.53
Reach-1	19.8*	70.00	101.25	102.72	102.36	102.85	0.004996	2.86	24.46	25.65	0.52
Reach-1	19.8*	80.00	101.25	102.82	102.42	102.95	0.004743	2.96	27.03	25.82	0.51
Reach-1	19.8*	90.00	101.25	102.91	102.48	103.05	0.004596	3.06	29.39	25.97	0.51
Reach-1	19.8*	100.00	101.25	103.00	102.53	103.15	0.004480	3.16	31.66	26.11	0.51
Reach-1	19.8*	200.00	101.25	103.67	103.00	103.92	0.004264	4.02	51.65	55.58	0.52
Reach-1	19.8*	500.00	101.25	104.58	104.35	104.91	0.004107	5.16	186.92	240.61	0.55
Reach-1	19.8*	750.00	101.25	105.00	104.76	105.31	0.003911	5.53	304.82	325.07	0.55
Reach-1	19.8*	1000.00	101.25	105.31	105.04	105.61	0.003839	5.83	413.57	386.95	0.55
Reach-1	19.8*	1500.00	101.25	105.73	105.48	106.02	0.003723	6.19	580.62	396.66	0.55
Reach-1	19.6*	10.00	100.99	101.58	101.46	101.65	0.009524	2.13	4.71	12.72	0.62
Reach-1	19.6*	20.00	100.99	101.84	101.64	101.93	0.007195	2.38	8.40	15.44	0.57
Reach-1	19.6*	30.00	100.99	102.04	101.78	102.15	0.006734	2.57	11.67	18.15	0.57
Reach-1	19.6*	40.00	100.99	102.22	101.89	102.33	0.006256	2.65	15.11	21.26	0.55
Reach-1	19.6*	50.00	100.99	102.37	102.01	102.48	0.005792	2.69	18.55	23.96	0.54
Reach-1	19.6*	60.00	100.99	102.51	102.11	102.62	0.005383	2.73	22.00	26.40	0.53
Reach-1	19.6*	70.00	100.99	102.63	102.20	102.75	0.004765	2.78	25.17	26.65	0.50
Reach-1	19.6*	80.00	100.99	102.73	102.27	102.86	0.004393	2.85	28.05	26.82	0.49

Reach-1	19.6*	90.00	100.99	102.83	102.35	102.96	0.004195	2.94	30.64	26.98	0.49
Reach-1	19.6*	100.00	100.99	102.92	102.41	103.06	0.004049	3.02	33.10	27.13	0.48
Reach-1	19.6*	200.00	100.99	103.61	102.89	103.84	0.003784	3.83	54.36	58.14	0.49
Reach-1	19.6*	500.00	100.99	104.51	104.23	104.82	0.003812	5.00	190.24	241.94	0.53
Reach-1	19.6*	750.00	100.99	104.93	104.67	105.23	0.003704	5.41	307.72	325.92	0.53
Reach-1	19.6*	1000.00	100.99	105.24	104.95	105.53	0.003618	5.69	419.42	389.31	0.54
Reach-1	19.6*	1500.00	100.99	105.65	105.40	105.94	0.003621	6.13	582.23	397.34	0.55
Reach-1	19.4*	10.00	100.74	101.51	101.21	101.55	0.002907	1.46	6.84	13.20	0.36
Reach-1	19.4*	20.00	100.74	101.77	101.39	101.83	0.003354	1.90	10.54	15.24	0.40
Reach-1	19.4*	30.00	100.74	101.96	101.54	102.04	0.003647	2.21	13.60	16.65	0.43
Reach-1	19.4*	40.00	100.74	102.13	101.66	102.22	0.004036	2.42	16.53	18.97	0.46
Reach-1	19.4*	50.00	100.74	102.28	101.77	102.38	0.004268	2.56	19.51	21.43	0.47
Reach-1	19.4*	60.00	100.74	102.41	101.87	102.52	0.004320	2.66	22.58	23.69	0.48
Reach-1	19.4*	70.00	100.74	102.54	101.96	102.65	0.004300	2.73	25.65	25.75	0.48
Reach-1	19.4*	80.00	100.74	102.65	102.06	102.77	0.004265	2.79	28.65	27.62	0.48
Reach-1	19.4*	90.00	100.74	102.75	102.15	102.88	0.004014	2.86	31.49	27.94	0.47
Reach-1	19.4*	100.00	100.74	102.85	102.23	102.98	0.003820	2.93	34.16	28.10	0.47
Reach-1	19.4*	200.00	100.74	103.55	102.79	103.76	0.003449	3.67	57.20	63.39	0.47
Reach-1	19.4*	500.00	100.74	104.46	104.10	104.74	0.003465	4.79	198.40	247.24	0.51
Reach-1	19.4*	750.00	100.74	104.87	104.57	105.15	0.003423	5.22	316.93	330.25	0.51
Reach-1	19.4*	1000.00	100.74	105.18	104.85	105.46	0.003387	5.52	428.81	392.83	0.52
Reach-1	19.4*	1500.00	100.74	105.58	105.31	105.86	0.003447	5.99	590.05	398.00	0.53
Reach-1	19.2*	10.00	100.48	101.49	100.94	101.51	0.000985	1.03	9.70	13.87	0.22
Reach-1	19.2*	20.00	100.48	101.74	101.13	101.78	0.001579	1.50	13.37	15.49	0.28
Reach-1	19.2*	30.00	100.48	101.93	101.29	101.98	0.002013	1.84	16.34	16.65	0.33
Reach-1	19.2*	40.00	100.48	102.09	101.42	102.15	0.002366	2.10	19.04	17.86	0.36
Reach-1	19.2*	50.00	100.48	102.22	101.54	102.31	0.002790	2.31	21.65	19.94	0.39
Reach-1	19.2*	60.00	100.48	102.35	101.64	102.45	0.003079	2.46	24.36	21.94	0.41
Reach-1	19.2*	70.00	100.48	102.47	101.74	102.58	0.003276	2.58	27.08	23.79	0.43
Reach-1	19.2*	80.00	100.48	102.58	101.82	102.69	0.003420	2.69	29.76	25.47	0.44
Reach-1	19.2*	90.00	100.48	102.68	101.91	102.80	0.003518	2.77	32.44	27.05	0.45
Reach-1	19.2*	100.00	100.48	102.78	101.98	102.91	0.003579	2.85	35.12	28.54	0.45
Reach-1	19.2*	200.00	100.48	103.50	102.67	103.69	0.003191	3.53	59.77	67.39	0.45
Reach-1	19.2*	500.00	100.48	104.40	103.99	104.66	0.003218	4.62	204.72	251.22	0.49
Reach-1	19.2*	750.00	100.48	104.81	104.47	105.08	0.003224	5.06	323.78	333.50	0.50
Reach-1	19.2*	1000.00	100.48	105.12	104.76	105.38	0.003224	5.38	435.32	394.50	0.51
Reach-1	19.2*	1500.00	100.48	105.52	105.23	105.79	0.003331	5.88	595.20	398.66	0.52
Reach-1	19.*	10.00	100.22	101.49	100.66	101.50	0.000422	0.78	12.80	14.45	0.15
Reach-1	19.*	20.00	100.22	101.73	100.87	101.75	0.000824	1.21	16.48	15.81	0.21
Reach-1	19.*	30.00	100.22	101.91	101.03	101.95	0.001171	1.55	19.40	16.78	0.25
Reach-1	19.*	40.00	100.22	102.06	101.16	102.11	0.001460	1.82	22.03	17.62	0.29
Reach-1	19.*	50.00	100.22	102.19	101.29	102.26	0.001793	2.05	24.40	19.00	0.32
Reach-1	19.*	60.00	100.22	102.31	101.40	102.39	0.002116	2.24	26.83	20.78	0.35
Reach-1	19.*	70.00	100.22	102.43	101.50	102.52	0.002378	2.39	29.28	22.40	0.37
Reach-1	19.*	80.00	100.22	102.53	101.59	102.63	0.002599	2.53	31.68	23.90	0.39
Reach-1	19.*	90.00	100.22	102.63	101.68	102.74	0.002780	2.64	34.08	25.30	0.40
Reach-1	19.*	100.00	100.22	102.72	101.76	102.84	0.002924	2.74	36.49	26.63	0.41
Reach-1	19.*	200.00	100.22	103.44	102.48	103.62	0.003017	3.42	62.21	71.89	0.44
Reach-1	19.*	500.00	100.22	104.36	103.88	104.60	0.002995	4.44	212.55	256.96	0.47
Reach-1	19.*	750.00	100.22	104.76	104.38	105.01	0.003026	4.89	333.21	338.93	0.48
Reach-1	19.*	1000.00	100.22	105.06	104.67	105.31	0.003046	5.21	445.29	397.80	0.49
Reach-1	19.*	1500.00	100.22	105.46	105.15	105.72	0.003191	5.73	603.65	399.34	0.51
Reach-1	18.8	10.00	99.97	101.48	100.40	101.49	0.000221	0.63	15.87	14.96	0.11
Reach-1	18.8	20.00	99.97	101.72	100.61	101.74	0.000487	1.02	19.58	16.14	0.16
Reach-1	18.8	30.00	99.97	101.90	100.78	101.92	0.000744	1.33	22.49	17.01	0.20

Reach-1	18.8	40.00	99.97	102.05	100.92	102.09	0.000977	1.59	25.08	17.74	0.24
Reach-1	18.8	50.00	99.97	102.17	101.04	102.22	0.001200	1.83	27.36	18.38	0.26
Reach-1	18.8	60.00	99.97	102.29	101.16	102.35	0.001481	2.03	29.59	19.97	0.29
Reach-1	18.8	70.00	99.97	102.40	101.26	102.47	0.001734	2.20	31.83	21.44	0.32
Reach-1	18.8	80.00	99.97	102.50	101.36	102.58	0.001965	2.35	34.01	22.79	0.34
Reach-1	18.8	90.00	99.97	102.59	101.45	102.68	0.002170	2.49	36.19	24.06	0.36
Reach-1	18.8	100.00	99.97	102.68	101.54	102.78	0.002348	2.61	38.39	25.28	0.37
Reach-1	18.8	200.00	99.97	103.39	102.25	103.56	0.002918	3.33	64.40	76.41	0.43
Reach-1	18.8	500.00	99.97	104.31	103.78	104.53	0.002811	4.28	220.71	262.79	0.45
Reach-1	18.8	750.00	99.97	104.71	104.28	104.94	0.002857	4.72	343.10	344.32	0.47
Reach-1	18.8	1000.00	99.97	105.02	104.58	105.25	0.002883	5.04	455.83	400.00	0.48
Reach-1	18.8	1500.00	99.97	105.41	105.06	105.65	0.003071	5.58	612.19	400.00	0.50
Reach-1	18.6*	10.00	100.17	101.47	100.62	101.48	0.000358	0.73	13.69	15.19	0.14
Reach-1	18.6*	20.00	100.17	101.70	100.82	101.73	0.000733	1.15	17.34	16.53	0.20
Reach-1	18.6*	30.00	100.17	101.87	100.98	101.91	0.001077	1.49	20.18	17.49	0.24
Reach-1	18.6*	40.00	100.17	102.01	101.11	102.06	0.001462	1.76	22.76	19.30	0.29
Reach-1	18.6*	50.00	100.17	102.13	101.23	102.19	0.001833	1.99	25.18	21.08	0.32
Reach-1	18.6*	60.00	100.17	102.24	101.34	102.32	0.002146	2.17	27.59	22.71	0.35
Reach-1	18.6*	70.00	100.17	102.35	101.43	102.43	0.002405	2.33	30.01	24.23	0.37
Reach-1	18.6*	80.00	100.17	102.44	101.52	102.54	0.002629	2.47	32.37	25.63	0.39
Reach-1	18.6*	90.00	100.17	102.53	101.61	102.63	0.002813	2.59	34.73	26.96	0.40
Reach-1	18.6*	100.00	100.17	102.62	101.69	102.73	0.002958	2.69	37.12	28.24	0.41
Reach-1	18.6*	200.00	100.17	103.32	102.40	103.50	0.002882	3.40	63.49	75.96	0.43
Reach-1	18.6*	500.00	100.17	104.24	103.76	104.47	0.002852	4.39	218.79	262.04	0.46
Reach-1	18.6*	750.00	100.17	104.65	104.24	104.88	0.002911	4.85	340.40	343.39	0.47
Reach-1	18.6*	1000.00	100.17	104.94	104.54	105.18	0.002980	5.20	450.05	398.92	0.49
Reach-1	18.6*	1500.00	100.17	105.33	105.01	105.59	0.003167	5.74	605.59	399.00	0.51
Reach-1	18.4*	10.00	100.38	101.46	100.85	101.47	0.000691	0.89	11.28	15.59	0.18
Reach-1	18.4*	20.00	100.38	101.68	101.03	101.71	0.001293	1.35	14.83	17.43	0.26
Reach-1	18.4*	30.00	100.38	101.83	101.18	101.88	0.001927	1.69	17.73	20.00	0.32
Reach-1	18.4*	40.00	100.38	101.96	101.30	102.02	0.002427	1.95	20.50	22.18	0.36
Reach-1	18.4*	50.00	100.38	102.07	101.41	102.15	0.002848	2.17	23.07	24.03	0.39
Reach-1	18.4*	60.00	100.38	102.18	101.51	102.26	0.003155	2.34	25.66	25.76	0.41
Reach-1	18.4*	70.00	100.38	102.28	101.61	102.37	0.003369	2.47	28.29	27.41	0.43
Reach-1	18.4*	80.00	100.38	102.37	101.70	102.48	0.003377	2.59	30.88	27.90	0.43
Reach-1	18.4*	90.00	100.38	102.46	101.79	102.57	0.003340	2.70	33.35	28.05	0.44
Reach-1	18.4*	100.00	100.38	102.54	101.87	102.67	0.003307	2.80	35.75	28.19	0.44
Reach-1	18.4*	200.00	100.38	103.25	102.43	103.44	0.003083	3.54	61.28	75.29	0.45
Reach-1	18.4*	500.00	100.38	104.18	103.75	104.42	0.002965	4.51	217.83	262.65	0.47
Reach-1	18.4*	750.00	100.38	104.57	104.21	104.82	0.003017	4.97	338.88	343.43	0.48
Reach-1	18.4*	1000.00	100.38	104.87	104.49	105.12	0.003075	5.31	448.07	397.78	0.50
Reach-1	18.4*	1500.00	100.38	105.26	104.95	105.52	0.003241	5.84	603.82	398.00	0.52
Reach-1	18.2*	10.00	100.58	101.43	101.05	101.45	0.001773	1.14	8.74	16.93	0.28
Reach-1	18.2*	20.00	100.58	101.63	101.23	101.67	0.002869	1.61	12.45	20.73	0.37
Reach-1	18.2*	30.00	100.58	101.77	101.36	101.82	0.003655	1.94	15.50	23.37	0.42
Reach-1	18.2*	40.00	100.58	101.89	101.48	101.96	0.004115	2.17	18.46	25.68	0.45
Reach-1	18.2*	50.00	100.58	101.99	101.58	102.08	0.004135	2.36	21.18	25.92	0.46
Reach-1	18.2*	60.00	100.58	102.09	101.67	102.19	0.004099	2.52	23.79	26.09	0.47
Reach-1	18.2*	70.00	100.58	102.19	101.75	102.30	0.004050	2.66	26.29	26.24	0.47
Reach-1	18.2*	80.00	100.58	102.28	101.82	102.40	0.003994	2.79	28.71	26.40	0.47
Reach-1	18.2*	90.00	100.58	102.37	101.89	102.50	0.003940	2.90	31.04	26.54	0.47
Reach-1	18.2*	100.00	100.58	102.45	101.95	102.59	0.003888	3.00	33.31	26.68	0.47
Reach-1	18.2*	200.00	100.58	103.15	102.40	103.37	0.003624	3.80	56.46	68.38	0.48
Reach-1	18.2*	500.00	100.58	104.09	103.75	104.35	0.003326	4.75	209.51	258.19	0.50
Reach-1	18.2*	750.00	100.58	104.48	104.18	104.75	0.003372	5.21	326.68	337.81	0.51
Reach-1	18.2*	1000.00	100.58	104.78	104.45	105.05	0.003387	5.54	435.65	394.88	0.52

Reach-1	18.2*	1500.00	100.58	105.18	104.90	105.45	0.003448	6.01	595.23	397.00	0.53
Reach-1	18	10.00	100.78	101.31	101.23	101.37	0.011839	1.94	5.17	19.03	0.65
Reach-1	18	20.00	100.78	101.48	101.37	101.56	0.010946	2.29	8.74	23.55	0.66
Reach-1	18	30.00	100.78	101.60	101.48	101.71	0.009567	2.57	11.67	23.77	0.65
Reach-1	18	40.00	100.78	101.72	101.55	101.84	0.008522	2.77	14.44	23.97	0.63
Reach-1	18	50.00	100.78	101.83	101.62	101.96	0.007766	2.93	17.06	24.16	0.61
Reach-1	18	60.00	100.78	101.93	101.69	102.08	0.007165	3.06	19.59	24.34	0.60
Reach-1	18	70.00	100.78	102.03	101.76	102.19	0.006705	3.18	22.02	24.52	0.59
Reach-1	18	80.00	100.78	102.13	101.82	102.30	0.006344	3.28	24.36	24.68	0.58
Reach-1	18	90.00	100.78	102.22	101.87	102.40	0.006063	3.38	26.61	24.84	0.58
Reach-1	18	100.00	100.78	102.31	101.93	102.49	0.005837	3.48	28.77	24.99	0.57
Reach-1	18	200.00	100.78	103.00	102.42	103.28	0.005102	4.30	47.88	49.93	0.57
Reach-1	18	500.00	100.78	103.93	103.76	104.27	0.004542	5.36	182.26	238.73	0.57
Reach-1	18	750.00	100.78	104.36	104.16	104.67	0.004130	5.64	303.61	325.89	0.56
Reach-1	18	1000.00	100.78	104.68	104.42	104.97	0.003923	5.86	417.18	390.21	0.55
Reach-1	18	1500.00	100.78	105.10	104.84	105.37	0.003766	6.19	583.59	396.00	0.55
Reach-1	17.8*	10.00	100.53	101.03	100.97	101.11	0.014280	2.24	4.47	15.19	0.73
Reach-1	17.8*	20.00	100.53	101.23	101.12	101.33	0.011607	2.59	7.72	18.01	0.70
Reach-1	17.8*	30.00	100.53	101.40	101.25	101.52	0.009585	2.69	11.16	21.34	0.66
Reach-1	17.8*	40.00	100.53	101.56	101.35	101.68	0.007752	2.72	14.70	23.56	0.61
Reach-1	17.8*	50.00	100.53	101.70	101.44	101.82	0.006478	2.78	17.97	24.24	0.57
Reach-1	17.8*	60.00	100.53	101.82	101.51	101.95	0.005728	2.86	20.95	24.54	0.55
Reach-1	17.8*	70.00	100.53	101.93	101.58	102.07	0.005288	2.96	23.68	24.82	0.53
Reach-1	17.8*	80.00	100.53	102.03	101.64	102.18	0.004989	3.05	26.25	25.07	0.52
Reach-1	17.8*	90.00	100.53	102.13	101.70	102.28	0.004778	3.14	28.69	25.31	0.52
Reach-1	17.8*	100.00	100.53	102.22	101.76	102.38	0.004619	3.22	31.02	25.54	0.52
Reach-1	17.8*	200.00	100.53	102.93	102.25	103.18	0.004194	4.01	51.34	51.96	0.52
Reach-1	17.8*	500.00	100.53	103.85	103.62	104.18	0.004136	5.21	183.59	237.24	0.55
Reach-1	17.8*	750.00	100.53	104.27	104.05	104.59	0.003920	5.57	301.77	322.75	0.55
Reach-1	17.8*	1000.00	100.53	104.58	104.32	104.89	0.003800	5.84	412.93	386.27	0.55
Reach-1	17.8*	1500.00	100.53	105.00	104.76	105.30	0.003706	6.22	579.65	396.66	0.55
Reach-1	17.6*	10.00	100.27	100.83	100.71	100.89	0.008396	1.96	5.10	14.21	0.58
Reach-1	17.6*	20.00	100.27	101.08	100.86	101.16	0.006178	2.20	9.08	16.78	0.53
Reach-1	17.6*	30.00	100.27	101.28	100.99	101.37	0.005550	2.40	12.49	18.69	0.52
Reach-1	17.6*	40.00	100.27	101.44	101.10	101.54	0.005335	2.52	15.85	21.39	0.52
Reach-1	17.6*	50.00	100.27	101.59	101.20	101.70	0.004979	2.60	19.23	23.57	0.51
Reach-1	17.6*	60.00	100.27	101.73	101.29	101.84	0.004499	2.67	22.48	24.52	0.49
Reach-1	17.6*	70.00	100.27	101.85	101.38	101.97	0.004181	2.75	25.43	24.96	0.48
Reach-1	17.6*	80.00	100.27	101.96	101.46	102.08	0.003982	2.84	28.16	25.33	0.47
Reach-1	17.6*	90.00	100.27	102.06	101.54	102.19	0.003854	2.93	30.73	25.67	0.47
Reach-1	17.6*	100.00	100.27	102.15	101.60	102.29	0.003762	3.01	33.17	26.00	0.47
Reach-1	17.6*	200.00	100.27	102.88	102.10	103.10	0.003589	3.78	54.66	55.43	0.48
Reach-1	17.6*	500.00	100.27	103.78	103.49	104.09	0.003747	5.02	188.19	239.32	0.53
Reach-1	17.6*	750.00	100.27	104.20	103.95	104.50	0.003660	5.44	305.36	323.78	0.54
Reach-1	17.6*	1000.00	100.27	104.51	104.23	104.81	0.003605	5.74	415.73	386.83	0.54
Reach-1	17.6*	1500.00	100.27	104.92	104.68	105.22	0.003591	6.17	580.82	397.34	0.55
Reach-1	17.4*	10.00	100.01	100.78	100.44	100.80	0.002188	1.29	7.73	14.54	0.31
Reach-1	17.4*	20.00	100.01	101.03	100.61	101.07	0.002650	1.71	11.66	16.55	0.36
Reach-1	17.4*	30.00	100.01	101.22	100.75	101.28	0.002926	2.01	14.93	17.96	0.39
Reach-1	17.4*	40.00	100.01	101.38	100.87	101.46	0.003170	2.23	17.95	19.60	0.41
Reach-1	17.4*	50.00	100.01	101.53	100.97	101.61	0.003394	2.38	20.97	21.78	0.43
Reach-1	17.4*	60.00	100.01	101.66	101.07	101.76	0.003475	2.49	24.07	23.81	0.44
Reach-1	17.4*	70.00	100.01	101.78	101.15	101.89	0.003374	2.59	27.05	24.71	0.44
Reach-1	17.4*	80.00	100.01	101.90	101.23	102.01	0.003301	2.68	29.84	25.40	0.44
Reach-1	17.4*	90.00	100.01	102.00	101.31	102.12	0.003246	2.77	32.46	25.88	0.44

Reach-1	17.4*	100.00	100.01	102.09	101.40	102.22	0.003211	2.86	34.97	26.33	0.44
Reach-1	17.4*	200.00	100.01	102.82	101.97	103.02	0.003194	3.60	58.06	61.97	0.46
Reach-1	17.4*	500.00	100.01	103.73	103.35	104.01	0.003355	4.78	197.52	245.46	0.50
Reach-1	17.4*	750.00	100.01	104.14	103.83	104.43	0.003349	5.23	315.53	328.60	0.51
Reach-1	17.4*	1000.00	100.01	104.45	104.13	104.73	0.003352	5.56	425.80	390.61	0.52
Reach-1	17.4*	1500.00	100.01	104.86	104.59	105.14	0.003404	6.03	589.13	398.00	0.53
Reach-1	17.2*	10.00	99.76	100.76	100.18	100.77	0.000791	0.94	10.61	14.82	0.20
Reach-1	17.2*	20.00	99.76	101.00	100.36	101.03	0.001311	1.39	14.42	16.42	0.26
Reach-1	17.2*	30.00	99.76	101.19	100.51	101.23	0.001689	1.71	17.53	17.56	0.30
Reach-1	17.2*	40.00	99.76	101.34	100.63	101.40	0.001968	1.97	20.35	18.54	0.33
Reach-1	17.2*	50.00	99.76	101.48	100.75	101.55	0.002306	2.17	23.03	20.37	0.36
Reach-1	17.2*	60.00	99.76	101.61	100.85	101.69	0.002551	2.32	25.82	22.24	0.38
Reach-1	17.2*	70.00	99.76	101.73	100.94	101.82	0.002727	2.45	28.59	23.96	0.39
Reach-1	17.2*	80.00	99.76	101.84	101.03	101.94	0.002786	2.56	31.31	24.99	0.40
Reach-1	17.2*	90.00	99.76	101.94	101.11	102.05	0.002819	2.65	33.91	25.78	0.41
Reach-1	17.2*	100.00	99.76	102.04	101.18	102.16	0.002844	2.75	36.42	26.45	0.41
Reach-1	17.2*	200.00	99.76	102.77	101.85	102.96	0.002965	3.47	60.76	66.83	0.44
Reach-1	17.2*	500.00	99.76	103.68	103.23	103.94	0.003109	4.60	204.67	250.24	0.48
Reach-1	17.2*	750.00	99.76	104.09	103.74	104.35	0.003147	5.06	323.38	332.55	0.50
Reach-1	17.2*	1000.00	99.76	104.39	104.01	104.66	0.003190	5.41	433.22	393.67	0.51
Reach-1	17.2*	1500.00	99.76	104.80	104.51	105.07	0.003283	5.90	595.10	398.66	0.52
Reach-1	17.*	10.00	99.50	100.75	99.93	100.76	0.000388	0.75	13.25	14.88	0.14
Reach-1	17.*	20.00	99.50	100.99	100.12	101.01	0.000772	1.18	16.93	16.22	0.20
Reach-1	17.*	30.00	99.50	101.17	100.28	101.20	0.001101	1.51	19.90	17.19	0.25
Reach-1	17.*	40.00	99.50	101.32	100.41	101.37	0.001375	1.77	22.56	18.02	0.28
Reach-1	17.*	50.00	99.50	101.45	100.53	101.51	0.001648	2.00	25.00	19.08	0.31
Reach-1	17.*	60.00	99.50	101.57	100.64	101.65	0.001942	2.18	27.47	20.81	0.33
Reach-1	17.*	70.00	99.50	101.69	100.74	101.77	0.002185	2.34	29.95	22.41	0.36
Reach-1	17.*	80.00	99.50	101.80	100.83	101.89	0.002383	2.47	32.43	23.90	0.37
Reach-1	17.*	90.00	99.50	101.90	100.92	102.00	0.002530	2.58	34.88	25.14	0.39
Reach-1	17.*	100.00	99.50	101.99	101.00	102.10	0.002621	2.68	37.30	26.07	0.39
Reach-1	17.*	200.00	99.50	102.72	101.70	102.90	0.002904	3.39	62.68	71.44	0.43
Reach-1	17.*	500.00	99.50	103.63	103.15	103.87	0.002948	4.44	212.19	256.17	0.47
Reach-1	17.*	750.00	99.50	104.04	103.65	104.29	0.002988	4.89	332.91	338.37	0.48
Reach-1	17.*	1000.00	99.50	104.34	103.95	104.59	0.003038	5.24	443.44	397.18	0.49
Reach-1	17.*	1500.00	99.50	104.74	104.43	105.00	0.003158	5.74	604.19	399.34	0.51
Reach-1	16.8	10.00	99.25	100.75	99.68	100.75	0.000229	0.64	15.65	14.89	0.11
Reach-1	16.8	20.00	99.25	100.98	99.89	101.00	0.000512	1.04	19.24	16.04	0.17
Reach-1	16.8	30.00	99.25	101.15	100.06	101.18	0.000784	1.36	22.08	16.89	0.21
Reach-1	16.8	40.00	99.25	101.30	100.20	101.34	0.001029	1.63	24.61	17.61	0.24
Reach-1	16.8	50.00	99.25	101.43	100.32	101.48	0.001256	1.86	26.90	18.24	0.27
Reach-1	16.8	60.00	99.25	101.55	100.44	101.61	0.001529	2.06	29.13	19.65	0.30
Reach-1	16.8	70.00	99.25	101.65	100.54	101.73	0.001790	2.23	31.35	21.14	0.32
Reach-1	16.8	80.00	99.25	101.76	100.64	101.84	0.002021	2.38	33.57	22.53	0.34
Reach-1	16.8	90.00	99.25	101.85	100.73	101.95	0.002225	2.51	35.79	23.83	0.36
Reach-1	16.8	100.00	99.25	101.94	100.82	102.05	0.002401	2.63	38.01	25.07	0.38
Reach-1	16.8	200.00	99.25	102.66	101.53	102.84	0.002945	3.34	64.05	75.47	0.43
Reach-1	16.8	500.00	99.25	103.59	103.06	103.81	0.002838	4.30	219.49	261.84	0.45
Reach-1	16.8	750.00	99.25	103.99	103.56	104.22	0.002867	4.73	342.45	343.94	0.47
Reach-1	16.8	1000.00	99.25	104.29	103.86	104.53	0.002916	5.06	453.67	400.00	0.48
Reach-1	16.8	1500.00	99.25	104.69	104.34	104.93	0.003058	5.57	613.18	400.00	0.50
Reach-1	16.6*	10.00	99.45	100.74	99.87	100.75	0.000309	0.69	14.52	15.87	0.13
Reach-1	16.6*	20.00	99.45	100.97	100.06	100.98	0.000646	1.10	18.24	17.20	0.19
Reach-1	16.6*	30.00	99.45	101.13	100.21	101.16	0.000954	1.42	21.18	18.18	0.23
Reach-1	16.6*	40.00	99.45	101.27	100.34	101.32	0.001267	1.68	23.82	19.60	0.27

Reach-1	16.6*	50.00	99.45	101.40	100.46	101.45	0.001583	1.90	26.33	21.32	0.30
Reach-1	16.6*	60.00	99.45	101.51	100.56	101.58	0.001848	2.08	28.86	22.90	0.33
Reach-1	16.6*	70.00	99.45	101.62	100.66	101.69	0.002073	2.23	31.34	24.37	0.35
Reach-1	16.6*	80.00	99.45	101.71	100.75	101.80	0.002212	2.37	33.80	25.29	0.36
Reach-1	16.6*	90.00	99.45	101.81	100.83	101.90	0.002325	2.49	36.19	26.08	0.37
Reach-1	16.6*	100.00	99.45	101.90	100.91	102.00	0.002417	2.59	38.54	26.82	0.38
Reach-1	16.6*	200.00	99.45	102.61	101.60	102.78	0.002698	3.34	64.68	76.82	0.42
Reach-1	16.6*	500.00	99.45	103.52	103.01	103.75	0.002771	4.37	219.21	261.70	0.46
Reach-1	16.6*	750.00	99.45	103.92	103.52	104.16	0.002861	4.85	339.96	342.62	0.47
Reach-1	16.6*	1000.00	99.45	104.21	103.82	104.46	0.002985	5.24	446.44	397.80	0.49
Reach-1	16.6*	1500.00	99.45	104.61	104.29	104.87	0.003126	5.76	605.90	399.00	0.51
Reach-1	16.4*	10.00	99.65	100.73	100.08	100.74	0.000515	0.79	12.72	17.02	0.16
Reach-1	16.4*	20.00	99.65	100.95	100.25	100.97	0.000969	1.21	16.55	18.62	0.23
Reach-1	16.4*	30.00	99.65	101.10	100.39	101.14	0.001431	1.53	19.66	20.86	0.28
Reach-1	16.4*	40.00	99.65	101.24	100.51	101.29	0.001807	1.77	22.59	22.86	0.31
Reach-1	16.4*	50.00	99.65	101.36	100.61	101.42	0.002075	1.97	25.37	24.25	0.34
Reach-1	16.4*	60.00	99.65	101.47	100.70	101.54	0.002219	2.14	28.09	24.99	0.36
Reach-1	16.4*	70.00	99.65	101.57	100.79	101.65	0.002326	2.28	30.67	25.54	0.37
Reach-1	16.4*	80.00	99.65	101.66	100.87	101.75	0.002407	2.41	33.16	25.99	0.38
Reach-1	16.4*	90.00	99.65	101.76	100.95	101.85	0.002478	2.53	35.54	26.41	0.38
Reach-1	16.4*	100.00	99.65	101.84	101.04	101.95	0.002537	2.64	37.86	26.82	0.39
Reach-1	16.4*	200.00	99.65	102.54	101.60	102.73	0.002759	3.44	63.22	76.38	0.43
Reach-1	16.4*	500.00	99.65	103.45	103.00	103.69	0.002885	4.52	215.95	260.33	0.47
Reach-1	16.4*	750.00	99.65	103.85	103.48	104.10	0.002987	5.00	335.09	340.72	0.49
Reach-1	16.4*	1000.00	99.65	104.12	103.77	104.39	0.003176	5.44	436.68	395.28	0.51
Reach-1	16.4*	1500.00	99.65	104.53	104.25	104.80	0.003276	5.94	597.39	398.00	0.53
Reach-1	16.2*	10.00	99.86	100.71	100.30	100.72	0.001233	0.99	10.07	18.41	0.24
Reach-1	16.2*	20.00	99.86	100.91	100.45	100.94	0.002024	1.42	14.10	21.89	0.31
Reach-1	16.2*	30.00	99.86	101.06	100.58	101.10	0.002485	1.72	17.46	23.71	0.35
Reach-1	16.2*	40.00	99.86	101.18	100.68	101.24	0.002693	1.95	20.53	24.45	0.37
Reach-1	16.2*	50.00	99.86	101.29	100.78	101.37	0.002831	2.15	23.28	24.77	0.39
Reach-1	16.2*	60.00	99.86	101.40	100.87	101.48	0.002901	2.31	25.95	25.09	0.40
Reach-1	16.2*	70.00	99.86	101.50	100.95	101.60	0.002962	2.46	28.46	25.37	0.41
Reach-1	16.2*	80.00	99.86	101.60	101.02	101.70	0.003007	2.59	30.87	25.65	0.42
Reach-1	16.2*	90.00	99.86	101.68	101.08	101.80	0.003051	2.71	33.15	25.91	0.42
Reach-1	16.2*	100.00	99.86	101.77	101.14	101.89	0.003086	2.83	35.37	26.16	0.43
Reach-1	16.2*	200.00	99.86	102.46	101.62	102.66	0.003228	3.67	59.19	73.48	0.46
Reach-1	16.2*	500.00	99.86	103.37	103.01	103.63	0.003178	4.71	211.62	259.10	0.49
Reach-1	16.2*	750.00	99.86	103.77	103.45	104.04	0.003244	5.18	329.59	338.99	0.50
Reach-1	16.2*	1000.00	99.86	104.05	103.73	104.33	0.003351	5.57	434.34	394.31	0.52
Reach-1	16.2*	1500.00	99.86	104.45	104.18	104.73	0.003427	6.05	593.86	397.00	0.54
Reach-1	16	10.00	100.06	100.62	100.51	100.67	0.009252	1.77	5.66	19.87	0.58
Reach-1	16	20.00	100.06	100.80	100.65	100.87	0.007992	2.08	9.62	23.61	0.57
Reach-1	16	30.00	100.06	100.94	100.76	101.02	0.006910	2.33	12.90	23.86	0.56
Reach-1	16	40.00	100.06	101.06	100.83	101.16	0.006256	2.52	15.89	24.07	0.55
Reach-1	16	50.00	100.06	101.17	100.90	101.28	0.005977	2.70	18.50	24.26	0.55
Reach-1	16	60.00	100.06	101.28	100.97	101.40	0.005630	2.84	21.12	24.45	0.54
Reach-1	16	70.00	100.06	101.38	101.04	101.51	0.005420	2.97	23.53	24.62	0.54
Reach-1	16	80.00	100.06	101.47	101.10	101.62	0.005251	3.10	25.85	24.79	0.53
Reach-1	16	90.00	100.06	101.56	101.16	101.72	0.005145	3.21	28.02	24.94	0.53
Reach-1	16	100.00	100.06	101.64	101.21	101.81	0.005055	3.32	30.11	25.09	0.53
Reach-1	16	200.00	100.06	102.30	101.70	102.58	0.004855	4.23	49.22	55.10	0.55
Reach-1	16	500.00	100.06	103.23	103.04	103.56	0.004367	5.28	186.64	242.42	0.56
Reach-1	16	750.00	100.06	103.65	103.44	103.96	0.004055	5.60	306.56	327.72	0.56
Reach-1	16	1000.00	100.06	103.96	103.70	104.25	0.003913	5.85	417.69	390.48	0.55
Reach-1	16	1500.00	100.06	104.38	104.12	104.66	0.003759	6.19	583.99	396.00	0.55

Reach-1	15.8*	10.00	99.81	100.36	100.28	100.44	0.013168	2.25	4.45	14.16	0.71
Reach-1	15.8*	20.00	99.81	100.57	100.45	100.67	0.011160	2.55	7.85	18.22	0.68
Reach-1	15.8*	30.00	99.81	100.76	100.58	100.86	0.009014	2.61	11.50	21.91	0.63
Reach-1	15.8*	40.00	99.81	100.92	100.68	101.02	0.007440	2.62	15.28	25.05	0.59
Reach-1	15.8*	50.00	99.81	101.05	100.77	101.16	0.006104	2.68	18.64	25.27	0.55
Reach-1	15.8*	60.00	99.81	101.17	100.86	101.29	0.005356	2.76	21.74	25.48	0.53
Reach-1	15.8*	70.00	99.81	101.28	100.92	101.41	0.004992	2.86	24.46	25.65	0.52
Reach-1	15.8*	80.00	99.81	101.38	100.98	101.51	0.004740	2.96	27.03	25.82	0.51
Reach-1	15.8*	90.00	99.81	101.47	101.04	101.61	0.004592	3.06	29.40	25.97	0.51
Reach-1	15.8*	100.00	99.81	101.56	101.09	101.71	0.004476	3.16	31.67	26.11	0.51
Reach-1	15.8*	200.00	99.81	102.23	101.56	102.48	0.004259	4.02	51.69	55.71	0.52
Reach-1	15.8*	500.00	99.81	103.15	102.92	103.47	0.004089	5.15	187.43	241.04	0.55
Reach-1	15.8*	750.00	99.81	103.56	103.32	103.87	0.003894	5.52	305.56	325.52	0.55
Reach-1	15.8*	1000.00	99.81	103.87	103.60	104.17	0.003830	5.82	414.08	387.21	0.55
Reach-1	15.8*	1500.00	99.81	104.29	104.04	104.58	0.003702	6.18	581.84	396.66	0.55
Reach-1	15.6*	10.00	99.55	100.14	100.02	100.21	0.009516	2.12	4.71	12.72	0.62
Reach-1	15.6*	20.00	99.55	100.41	100.20	100.49	0.007192	2.38	8.40	15.44	0.57
Reach-1	15.6*	30.00	99.55	100.60	100.34	100.71	0.006731	2.57	11.67	18.15	0.56
Reach-1	15.6*	40.00	99.55	100.78	100.45	100.89	0.006253	2.65	15.11	21.26	0.55
Reach-1	15.6*	50.00	99.55	100.93	100.57	101.04	0.005788	2.69	18.56	23.97	0.54
Reach-1	15.6*	60.00	99.55	101.07	100.67	101.18	0.005379	2.73	22.00	26.40	0.53
Reach-1	15.6*	70.00	99.55	101.19	100.76	101.31	0.004760	2.78	25.17	26.65	0.50
Reach-1	15.6*	80.00	99.55	101.29	100.83	101.42	0.004389	2.85	28.06	26.82	0.49
Reach-1	15.6*	90.00	99.55	101.39	100.91	101.52	0.004191	2.94	30.65	26.98	0.49
Reach-1	15.6*	100.00	99.55	101.48	100.97	101.62	0.004045	3.02	33.11	27.13	0.48
Reach-1	15.6*	200.00	99.55	102.17	101.45	102.40	0.003778	3.82	54.41	58.30	0.49
Reach-1	15.6*	500.00	99.55	103.08	102.79	103.38	0.003790	4.99	190.92	242.51	0.53
Reach-1	15.6*	750.00	99.55	103.49	103.24	103.79	0.003683	5.40	308.70	326.53	0.53
Reach-1	15.6*	1000.00	99.55	103.80	103.51	104.09	0.003607	5.68	420.07	389.65	0.54
Reach-1	15.6*	1500.00	99.55	104.21	103.96	104.50	0.003593	6.11	583.92	397.34	0.54
Reach-1	15.4*	10.00	99.30	100.07	99.77	100.11	0.002904	1.46	6.84	13.20	0.36
Reach-1	15.4*	20.00	99.30	100.33	99.95	100.39	0.003353	1.90	10.54	15.24	0.40
Reach-1	15.4*	30.00	99.30	100.52	100.10	100.60	0.003645	2.20	13.61	16.64	0.43
Reach-1	15.4*	40.00	99.30	100.69	100.22	100.78	0.004034	2.42	16.53	18.97	0.46
Reach-1	15.4*	50.00	99.30	100.84	100.33	100.94	0.004265	2.56	19.52	21.43	0.47
Reach-1	15.4*	60.00	99.30	100.97	100.43	101.08	0.004317	2.66	22.59	23.69	0.48
Reach-1	15.4*	70.00	99.30	101.10	100.52	101.21	0.004297	2.73	25.65	25.75	0.48
Reach-1	15.4*	80.00	99.30	101.21	100.62	101.33	0.004262	2.79	28.65	27.62	0.48
Reach-1	15.4*	90.00	99.30	101.31	100.71	101.44	0.004010	2.86	31.50	27.93	0.47
Reach-1	15.4*	100.00	99.30	101.41	100.79	101.54	0.003816	2.93	34.17	28.09	0.47
Reach-1	15.4*	200.00	99.30	102.11	101.35	102.32	0.003455	3.67	56.88	61.52	0.47
Reach-1	15.4*	500.00	99.30	103.01	102.67	103.30	0.003535	4.83	195.42	244.88	0.51
Reach-1	15.4*	750.00	99.30	103.43	103.13	103.71	0.003493	5.26	313.03	328.12	0.52
Reach-1	15.4*	1000.00	99.30	103.73	103.42	104.02	0.003459	5.57	423.96	390.71	0.53
Reach-1	15.4*	1500.00	99.30	104.14	103.88	104.42	0.003500	6.03	586.32	398.00	0.54
Reach-1	15.2*	10.00	99.04	100.05	99.50	100.07	0.000985	1.03	9.70	13.87	0.22
Reach-1	15.2*	20.00	99.04	100.30	99.69	100.34	0.001579	1.50	13.37	15.49	0.28
Reach-1	15.2*	30.00	99.04	100.49	99.85	100.54	0.002012	1.84	16.34	16.65	0.33
Reach-1	15.2*	40.00	99.04	100.65	99.98	100.71	0.002365	2.10	19.05	17.86	0.36
Reach-1	15.2*	50.00	99.04	100.78	100.09	100.87	0.002789	2.31	21.65	19.95	0.39
Reach-1	15.2*	60.00	99.04	100.91	100.20	101.01	0.003077	2.46	24.36	21.95	0.41
Reach-1	15.2*	70.00	99.04	101.03	100.30	101.14	0.003273	2.58	27.09	23.79	0.43
Reach-1	15.2*	80.00	99.04	101.14	100.39	101.25	0.003417	2.69	29.77	25.48	0.44
Reach-1	15.2*	90.00	99.04	101.24	100.47	101.36	0.003514	2.77	32.45	27.06	0.45
Reach-1	15.2*	100.00	99.04	101.34	100.55	101.47	0.003574	2.85	35.14	28.55	0.45

Reach-1	15.2*	200.00	99.04	102.06	101.23	102.25	0.003187	3.53	59.82	67.54	0.45
Reach-1	15.2*	500.00	99.04	102.97	102.55	103.22	0.003217	4.62	204.77	251.26	0.49
Reach-1	15.2*	750.00	99.04	103.37	103.03	103.64	0.003222	5.06	323.91	333.58	0.50
Reach-1	15.2*	1000.00	99.04	103.68	103.32	103.94	0.003225	5.38	435.22	394.47	0.51
Reach-1	15.2*	1500.00	99.04	104.08	103.79	104.35	0.003320	5.87	595.94	398.66	0.52
Reach-1	15.*	10.00	98.79	100.05	99.23	100.06	0.000425	0.78	12.77	14.45	0.15
Reach-1	15.*	20.00	98.79	100.29	99.43	100.31	0.000830	1.22	16.45	15.81	0.21
Reach-1	15.*	30.00	98.79	100.47	99.59	100.51	0.001178	1.55	19.37	16.78	0.25
Reach-1	15.*	40.00	98.79	100.62	99.73	100.67	0.001467	1.82	21.99	17.62	0.29
Reach-1	15.*	50.00	98.79	100.75	99.85	100.82	0.001802	2.05	24.36	19.00	0.32
Reach-1	15.*	60.00	98.79	100.87	99.96	100.95	0.002125	2.24	26.80	20.78	0.35
Reach-1	15.*	70.00	98.79	100.99	100.06	101.08	0.002387	2.39	29.24	22.41	0.37
Reach-1	15.*	80.00	98.79	101.09	100.15	101.19	0.002608	2.53	31.65	23.90	0.39
Reach-1	15.*	90.00	98.79	101.19	100.24	101.30	0.002788	2.64	34.05	25.30	0.40
Reach-1	15.*	100.00	98.79	101.28	100.32	101.40	0.002931	2.74	36.46	26.64	0.41
Reach-1	15.*	200.00	98.79	102.00	101.05	102.18	0.003020	3.42	62.22	72.00	0.44
Reach-1	15.*	500.00	98.79	102.92	102.45	103.16	0.002995	4.44	212.63	257.05	0.47
Reach-1	15.*	750.00	98.79	103.32	102.93	103.57	0.003024	4.89	333.45	339.09	0.48
Reach-1	15.*	1000.00	98.79	103.62	103.23	103.87	0.003045	5.21	445.39	397.84	0.49
Reach-1	15.*	1500.00	98.79	104.02	103.70	104.28	0.003178	5.72	604.64	399.34	0.51
Reach-1	14.8	10.00	98.53	100.04	98.96	100.05	0.000220	0.63	15.87	14.96	0.11
Reach-1	14.8	20.00	98.53	100.28	99.17	100.30	0.000487	1.02	19.58	16.14	0.16
Reach-1	14.8	30.00	98.53	100.46	99.34	100.48	0.000744	1.33	22.49	17.01	0.20
Reach-1	14.8	40.00	98.53	100.61	99.48	100.65	0.000977	1.59	25.08	17.74	0.24
Reach-1	14.8	50.00	98.53	100.73	99.60	100.78	0.001200	1.83	27.36	18.38	0.26
Reach-1	14.8	60.00	98.53	100.85	99.72	100.91	0.001481	2.03	29.60	19.97	0.29
Reach-1	14.8	70.00	98.53	100.96	99.82	101.03	0.001734	2.20	31.83	21.45	0.32
Reach-1	14.8	80.00	98.53	101.06	99.92	101.14	0.001964	2.35	34.02	22.80	0.34
Reach-1	14.8	90.00	98.53	101.15	100.01	101.24	0.002169	2.49	36.20	24.07	0.36
Reach-1	14.8	100.00	98.53	101.24	100.10	101.34	0.002347	2.60	38.40	25.28	0.37
Reach-1	14.8	200.00	98.53	101.95	100.81	102.12	0.002914	3.33	64.46	76.55	0.43
Reach-1	14.8	500.00	98.53	102.87	102.35	103.09	0.002810	4.28	220.78	262.84	0.45
Reach-1	14.8	750.00	98.53	103.28	102.84	103.50	0.002854	4.72	343.30	344.44	0.47
Reach-1	14.8	1000.00	98.53	103.58	103.15	103.81	0.002884	5.04	455.77	400.00	0.48
Reach-1	14.8	1500.00	98.53	103.97	103.62	104.21	0.003057	5.57	613.24	400.00	0.50
Reach-1	14.6*	10.00	98.73	100.03	99.18	100.04	0.000358	0.73	13.69	15.19	0.14
Reach-1	14.6*	20.00	98.73	100.26	99.38	100.29	0.000733	1.15	17.34	16.53	0.20
Reach-1	14.6*	30.00	98.73	100.43	99.54	100.47	0.001077	1.49	20.18	17.49	0.24
Reach-1	14.6*	40.00	98.73	100.57	99.67	100.62	0.001462	1.76	22.76	19.30	0.29
Reach-1	14.6*	50.00	98.73	100.69	99.79	100.75	0.001833	1.99	25.18	21.09	0.32
Reach-1	14.6*	60.00	98.73	100.80	99.90	100.88	0.002145	2.17	27.60	22.72	0.35
Reach-1	14.6*	70.00	98.73	100.91	99.99	100.99	0.002404	2.33	30.02	24.24	0.37
Reach-1	14.6*	80.00	98.73	101.00	100.08	101.10	0.002627	2.47	32.38	25.64	0.39
Reach-1	14.6*	90.00	98.73	101.09	100.17	101.19	0.002810	2.59	34.74	26.97	0.40
Reach-1	14.6*	100.00	98.73	101.18	100.25	101.29	0.002955	2.69	37.13	28.24	0.41
Reach-1	14.6*	200.00	98.73	101.89	100.96	102.06	0.002877	3.40	63.56	76.13	0.43
Reach-1	14.6*	500.00	98.73	102.80	102.33	103.03	0.002849	4.39	218.93	262.15	0.46
Reach-1	14.6*	750.00	98.73	103.21	102.80	103.45	0.002905	4.84	340.74	343.59	0.47
Reach-1	14.6*	1000.00	98.73	103.50	103.10	103.74	0.002994	5.21	449.03	398.67	0.49
Reach-1	14.6*	1500.00	98.73	103.89	103.57	104.15	0.003147	5.73	607.04	399.00	0.51
Reach-1	14.4*	10.00	98.94	100.02	99.41	100.03	0.000691	0.89	11.28	15.59	0.18
Reach-1	14.4*	20.00	98.94	100.24	99.59	100.27	0.001293	1.35	14.83	17.42	0.26
Reach-1	14.4*	30.00	98.94	100.39	99.74	100.44	0.001928	1.69	17.73	19.99	0.32
Reach-1	14.4*	40.00	98.94	100.52	99.86	100.58	0.002427	1.95	20.50	22.18	0.36
Reach-1	14.4*	50.00	98.94	100.63	99.97	100.71	0.002847	2.17	23.07	24.02	0.39

Reach-1	14.4*	60.00	98.94	100.74	100.07	100.82	0.003154	2.34	25.66	25.76	0.41
Reach-1	14.4*	70.00	98.94	100.84	100.17	100.93	0.003367	2.47	28.30	27.41	0.43
Reach-1	14.4*	80.00	98.94	100.93	100.26	101.04	0.003374	2.59	30.88	27.89	0.43
Reach-1	14.4*	90.00	98.94	101.02	100.35	101.13	0.003336	2.70	33.36	28.04	0.44
Reach-1	14.4*	100.00	98.94	101.11	100.43	101.23	0.003303	2.80	35.76	28.18	0.44
Reach-1	14.4*	200.00	98.94	101.81	100.99	102.00	0.003093	3.55	60.83	73.38	0.45
Reach-1	14.4*	500.00	98.94	102.73	102.31	102.98	0.003039	4.56	214.11	259.90	0.48
Reach-1	14.4*	750.00	98.94	103.13	102.77	103.38	0.003097	5.02	333.77	340.69	0.49
Reach-1	14.4*	1000.00	98.94	103.41	103.06	103.67	0.003229	5.42	438.08	395.96	0.51
Reach-1	14.4*	1500.00	98.94	103.81	103.52	104.08	0.003305	5.89	599.13	398.00	0.52
Reach-1	14.2*	10.00	99.14	99.99	99.61	100.01	0.001772	1.14	8.75	16.93	0.28
Reach-1	14.2*	20.00	99.14	100.19	99.79	100.23	0.002870	1.61	12.45	20.73	0.37
Reach-1	14.2*	30.00	99.14	100.33	99.92	100.38	0.003655	1.94	15.50	23.37	0.42
Reach-1	14.2*	40.00	99.14	100.45	100.04	100.52	0.004114	2.17	18.46	25.68	0.45
Reach-1	14.2*	50.00	99.14	100.55	100.14	100.64	0.004133	2.36	21.19	25.92	0.46
Reach-1	14.2*	60.00	99.14	100.65	100.23	100.75	0.004095	2.52	23.80	26.09	0.47
Reach-1	14.2*	70.00	99.14	100.75	100.31	100.86	0.004044	2.66	26.30	26.24	0.47
Reach-1	14.2*	80.00	99.14	100.84	100.38	100.96	0.003988	2.79	28.72	26.40	0.47
Reach-1	14.2*	90.00	99.14	100.93	100.45	101.06	0.003932	2.90	31.06	26.54	0.47
Reach-1	14.2*	100.00	99.14	101.01	100.51	101.15	0.003881	3.00	33.33	26.68	0.47
Reach-1	14.2*	200.00	99.14	101.71	100.96	101.93	0.003619	3.79	56.51	68.53	0.48
Reach-1	14.2*	500.00	99.14	102.65	102.31	102.91	0.003341	4.76	208.96	257.76	0.50
Reach-1	14.2*	750.00	99.14	103.04	102.74	103.31	0.003368	5.21	326.88	337.93	0.51
Reach-1	14.2*	1000.00	99.14	103.34	103.02	103.61	0.003404	5.55	434.68	394.63	0.52
Reach-1	14.2*	1500.00	99.14	103.74	103.45	104.01	0.003443	6.00	595.58	397.00	0.53
Reach-1	14	10.00	99.34	99.87	99.79	99.93	0.011811	1.93	5.17	19.03	0.65
Reach-1	14	20.00	99.34	100.04	99.93	100.12	0.010963	2.29	8.73	23.55	0.66
Reach-1	14	30.00	99.34	100.16	100.04	100.27	0.009568	2.57	11.67	23.77	0.65
Reach-1	14	40.00	99.34	100.28	100.11	100.40	0.008514	2.77	14.44	23.97	0.63
Reach-1	14	50.00	99.34	100.39	100.18	100.52	0.007753	2.93	17.07	24.16	0.61
Reach-1	14	60.00	99.34	100.49	100.25	100.64	0.007147	3.06	19.61	24.34	0.60
Reach-1	14	70.00	99.34	100.59	100.32	100.75	0.006684	3.18	22.04	24.52	0.59
Reach-1	14	80.00	99.34	100.69	100.38	100.86	0.006323	3.28	24.38	24.69	0.58
Reach-1	14	90.00	99.34	100.78	100.43	100.96	0.006041	3.38	26.63	24.84	0.58
Reach-1	14	100.00	99.34	100.87	100.49	101.05	0.005816	3.47	28.81	25.00	0.57
Reach-1	14	200.00	99.34	101.56	100.98	101.84	0.005091	4.29	47.94	50.15	0.57
Reach-1	14	500.00	99.34	102.49	102.32	102.83	0.004528	5.35	182.61	239.02	0.57
Reach-1	14	750.00	99.34	102.92	102.72	103.23	0.004119	5.63	304.05	326.16	0.56
Reach-1	14	1000.00	99.34	103.23	102.98	103.53	0.003952	5.87	415.68	389.43	0.56
Reach-1	14	1500.00	99.34	103.66	103.40	103.94	0.003754	6.19	584.24	396.00	0.55
Reach-1	13.8*	10.00	99.09	99.59	99.53	99.67	0.014361	2.24	8.46	15.18	0.73
Reach-1	13.8*	20.00	99.09	99.79	99.68	99.89	0.011587	2.59	7.72	18.01	0.70
Reach-1	13.8*	30.00	99.09	99.96	99.81	100.08	0.009559	2.69	11.17	21.35	0.65
Reach-1	13.8*	40.00	99.09	100.12	99.91	100.24	0.007728	2.72	14.72	23.57	0.61
Reach-1	13.8*	50.00	99.09	100.26	100.00	100.38	0.006455	2.78	17.99	24.24	0.57
Reach-1	13.8*	60.00	99.09	100.38	100.07	100.51	0.005704	2.86	20.97	24.55	0.55
Reach-1	13.8*	70.00	99.09	100.49	100.14	100.63	0.005264	2.95	23.71	24.82	0.53
Reach-1	13.8*	80.00	99.09	100.59	100.20	100.74	0.004966	3.04	26.29	25.08	0.52
Reach-1	13.8*	90.00	99.09	100.69	100.26	100.84	0.004756	3.13	28.73	25.32	0.52
Reach-1	13.8*	100.00	99.09	100.78	100.32	100.94	0.004598	3.22	31.07	25.55	0.51
Reach-1	13.8*	200.00	99.09	101.49	100.81	101.74	0.004183	4.00	51.41	52.22	0.52
Reach-1	13.8*	500.00	99.09	102.41	102.18	102.74	0.004118	5.20	184.07	237.65	0.55
Reach-1	13.8*	750.00	99.09	102.83	102.61	103.15	0.003903	5.56	302.47	323.19	0.55
Reach-1	13.8*	1000.00	99.09	103.14	102.88	103.45	0.003834	5.86	411.08	385.31	0.55
Reach-1	13.8*	1500.00	99.09	103.57	103.32	103.86	0.003689	6.21	580.62	396.66	0.55

Reach-1	13.6*	10.00	98.83	99.39	99.27	99.45	0.008252	1.95	5.13	14.23	0.57
Reach-1	13.6*	20.00	98.83	99.65	99.42	99.72	0.006144	2.20	9.09	16.79	0.53
Reach-1	13.6*	30.00	98.83	99.84	99.55	99.93	0.005527	2.40	12.51	18.71	0.52
Reach-1	13.6*	40.00	98.83	100.01	99.66	100.10	0.005315	2.52	15.87	21.40	0.52
Reach-1	13.6*	50.00	98.83	100.16	99.76	100.26	0.004953	2.59	19.27	23.58	0.51
Reach-1	13.6*	60.00	98.83	100.29	99.86	100.40	0.004474	2.66	22.52	24.53	0.49
Reach-1	13.6*	70.00	98.83	100.41	99.94	100.53	0.004156	2.75	25.48	24.97	0.48
Reach-1	13.6*	80.00	98.83	100.52	100.02	100.64	0.003960	2.84	28.21	25.34	0.47
Reach-1	13.6*	90.00	98.83	100.62	100.10	100.75	0.003833	2.92	30.78	25.68	0.47
Reach-1	13.6*	100.00	98.83	100.72	100.16	100.86	0.003742	3.01	33.23	26.00	0.47
Reach-1	13.6*	200.00	98.83	101.44	100.66	101.66	0.003579	3.78	54.74	55.73	0.48
Reach-1	13.6*	500.00	98.83	102.34	102.04	102.65	0.003726	5.00	188.83	239.86	0.53
Reach-1	13.6*	750.00	98.83	102.76	102.50	103.07	0.003640	5.43	306.28	324.36	0.53
Reach-1	13.6*	1000.00	98.83	103.07	102.78	103.37	0.003576	5.72	417.45	387.73	0.54
Reach-1	13.6*	1500.00	98.83	103.49	103.24	103.78	0.003569	6.16	582.20	397.34	0.55
Reach-1	13.4*	10.00	98.58	99.34	99.00	99.36	0.002214	1.30	7.70	14.55	0.31
Reach-1	13.4*	20.00	98.58	99.59	99.17	99.63	0.002682	1.72	11.62	16.55	0.36
Reach-1	13.4*	30.00	98.58	99.78	99.31	99.84	0.002952	2.01	14.89	17.96	0.39
Reach-1	13.4*	40.00	98.58	99.94	99.43	100.02	0.003193	2.23	17.91	19.61	0.41
Reach-1	13.4*	50.00	98.58	100.09	99.53	100.17	0.003410	2.39	20.94	21.79	0.43
Reach-1	13.4*	60.00	98.58	100.22	99.63	100.32	0.003484	2.49	24.06	23.83	0.44
Reach-1	13.4*	70.00	98.58	100.35	99.72	100.45	0.003375	2.59	27.05	24.72	0.44
Reach-1	13.4*	80.00	98.58	100.46	99.80	100.57	0.003301	2.68	29.84	25.40	0.44
Reach-1	13.4*	90.00	98.58	100.56	99.88	100.68	0.003244	2.77	32.47	25.87	0.44
Reach-1	13.4*	100.00	98.58	100.66	99.96	100.78	0.003208	2.86	34.98	26.32	0.44
Reach-1	13.4*	200.00	98.58	101.38	100.53	101.58	0.003208	3.60	57.72	60.17	0.46
Reach-1	13.4*	500.00	98.58	102.29	101.91	102.57	0.003424	4.82	194.62	243.18	0.51
Reach-1	13.4*	750.00	98.58	102.70	102.40	102.99	0.003419	5.28	311.69	326.52	0.52
Reach-1	13.4*	1000.00	98.58	103.01	102.70	103.30	0.003402	5.59	422.42	389.26	0.52
Reach-1	13.4*	1500.00	98.58	103.41	103.16	103.70	0.003469	6.08	584.67	398.00	0.54
Reach-1	13.2*	10.00	98.32	99.32	98.74	99.33	0.000787	0.94	10.63	14.83	0.20
Reach-1	13.2*	20.00	98.32	99.56	98.92	99.59	0.001310	1.39	14.43	16.42	0.26
Reach-1	13.2*	30.00	98.32	99.75	99.07	99.79	0.001686	1.71	17.54	17.57	0.30
Reach-1	13.2*	40.00	98.32	99.90	99.19	99.96	0.001964	1.96	20.36	18.54	0.33
Reach-1	13.2*	50.00	98.32	100.04	99.31	100.11	0.002301	2.17	23.06	20.39	0.36
Reach-1	13.2*	60.00	98.32	100.17	99.41	100.26	0.002542	2.32	25.86	22.26	0.38
Reach-1	13.2*	70.00	98.32	100.29	99.50	100.39	0.002715	2.44	28.64	23.99	0.39
Reach-1	13.2*	80.00	98.32	100.40	99.59	100.51	0.002772	2.55	31.36	25.01	0.40
Reach-1	13.2*	90.00	98.32	100.51	99.67	100.62	0.002804	2.65	33 97	25.80	0.41
Reach-1	13.2*	100.00	98.32	100.60	99.74	100.72	0.002829	2.74	36.49	26.47	0.41
Reach-1	13.2*	200.00	98.32	101.33	100.41	101.52	0.002958	3.47	60.85	67.10	0.44
Reach-1	13.2*	500.00	98.32	102.24	101.80	102.50	0.003108	4.60	204.74	250.29	0.48
Reach-1	13.2*	750.00	98.32	102.65	102.30	102.92	0.003145	5.06	323.49	332.61	0.50
Reach-1	13.2*	1000.00	98.32	102.95	102.57	103.22	0.003168	5.40	434.61	394.02	0.51
Reach-1	13.2*	1500.00	98.32	103.36	103.07	103.63	0.003285	5.91	594.97	398.66	0.52
Reach-1	13.*	10.00	98.07	99.31	98.49	99.32	0.000390	0.76	13.23	14.89	0.14
Reach-1	13.*	20.00	98.07	99.55	98.69	99.57	0.000777	1.18	16.90	16.22	0.20
Reach-1	13.*	30.00	98.07	99.73	98.84	99.76	0.001107	1.51	19.86	17.19	0.25
Reach-1	13.*	40.00	98.07	99.88	98.98	99.93	0.001381	1.78	22.53	18.02	0.28
Reach-1	13.*	50.00	98.07	100.01	99.09	100.07	0.001654	2.00	24.98	19.09	0.31
Reach-1	13.*	60.00	98.07	100.14	99.20	100.21	0.001945	2.18	27.47	20.83	0.34
Reach-1	13.*	70.00	98.07	100.25	99.30	100.34	0.002186	2.34	29.96	22.44	0.36
Reach-1	13.*	80.00	98.07	100.36	99.39	100.45	0.002384	2.47	32.44	23.93	0.37
Reach-1	13.*	90.00	98.07	100.46	99.48	100.56	0.002527	2.58	34.90	25.17	0.39
Reach-1	13.*	100.00	98.07	100.55	99.56	100.66	0.002617	2.68	37.33	26.09	0.39
Reach-1	13.*	200.00	98.07	101.28	100.27	101.46	0.002903	3.39	62.73	71.69	0.43

Reach-1	13.*	500.00	98.07	102.19	101.70	102.43	0.002948	4.44	212.28	256.28	0.47
Reach-1	13.*	750.00	98.07	102.60	102.21	102.85	0.002986	4.89	333.12	330.52	0.48
Reach-1	13.*	1000.00	98.07	102.90	102.51	103.15	0.003012	5.22	445.29	397.65	0.49
Reach-1	13.*	1500.00	98.07	103.30	102.98	103.56	0.003159	5.74	604.15	399.34	0.51
Reach-1	12.8	10.00	97.81	99.31	98.24	99.32	0.000228	0.64	15.67	14.90	0.11
Reach-1	12.8	20.00	97.81	99.54	98.45	99.56	0.000512	1.04	19.24	16.04	0.17
Reach-1	12.8	30.00	97.81	99.71	98.62	99.74	0.000783	1.36	22.08	16.89	0.21
Reach-1	12.8	40.00	97.81	99.86	98.76	99.90	0.001028	1.62	24.62	17.61	0.24
Reach-1	12.8	50.00	97.81	99.99	98.88	100.04	0.001254	1.86	26.92	18.25	0.27
Reach-1	12.8	60.00	97.81	100.11	99.00	100.17	0.001525	2.06	29.16	19.68	0.30
Reach-1	12.8	70.00	97.81	100.22	99.10	100.29	0.001785	2.23	31.40	21.17	0.32
Reach-1	12.8	80.00	97.81	100.32	99.20	100.41	0.002014	2.38	33.63	22.56	0.34
Reach-1	12.8	90.00	97.81	100.41	99.29	100.51	0.002216	2.51	35.85	23.87	0.36
Reach-1	12.8	100.00	97.81	100.51	99.38	100.61	0.002390	2.63	38.08	25.11	0.38
Reach-1	12.8	200.00	97.81	101.23	100.09	101.40	0.002936	3.34	64.17	75.78	0.43
Reach-1	12.8	500.00	97.81	102.15	101.62	102.37	0.002836	4.29	219.58	261.91	0.45
Reach-1	12.8	750.00	97.81	102.55	102.12	102.78	0.002864	4.73	342.62	344.04	0.47
Reach-1	12.8	1000.00	97.81	102.86	102.42	103.09	0.002884	5.04	455.77	400.00	0.48
Reach-1	12.8	1500.00	97.81	103.25	102.90	103.49	0.003060	5.57	613.03	400.00	0.50
Reach-1	12.6*	10.00	98.01	99.30	98.43	99.31	0.000307	0.69	14.54	15.88	0.13
Reach-1	12.6*	20.00	98.01	99.53	98.62	99.55	0.000646	1.10	18.24	17.20	0.19
Reach-1	12.6*	30.00	98.01	99.69	98.77	99.72	0.000953	1.42	21.18	18.19	0.23
Reach-1	12.6*	40.00	98.01	99.83	98.90	99.88	0.001266	1.68	23.83	19.61	0.27
Reach-1	12.6*	50.00	98.01	99.96	99.02	100.01	0.001579	1.90	26.36	21.33	0.30
Reach-1	12.6*	60.00	98.01	100.07	99.12	100.14	0.001842	2.08	28.90	22.93	0.33
Reach-1	12.6*	70.00	98.01	100.18	99.22	100.26	0.002063	2.23	31.40	24.40	0.35
Reach-1	12.6*	80.00	98.01	100.28	99.31	100.36	0.002200	2.36	33.87	25.31	0.36
Reach-1	12.6*	90.00	98.01	100.37	99.39	100.47	0.002311	2.48	36.27	26.10	0.37
Reach-1	12.6*	100.00	98.01	100.46	99.47	100.56	0.002403	2.59	38.62	26.84	0.38
Reach-1	12.6*	200.00	98.01	101.17	100.16	101.34	0.002690	3.34	64.82	77.17	0.42
Reach-1	12.6*	500.00	98.01	102.08	101.57	102.31	0.002769	4.37	219.32	261.78	0.46
Reach-1	12.6*	750.00	98.01	102.48	102.08	102.72	0.002856	4.85	340.24	342.78	0.47
Reach-1	12.6*	1000.00	98.01	102.78	102.38	103.02	0.002936	5.21	449.83	398.65	0.49
Reach-1	12.6*	1500.00	98.01	103.17	102.85	103.43	0.003129	5.76	605.71	399.00	0.51
Reach-1	12.4*	10.00	98.22	99.29	98.64	99.30	0.000518	0.79	12.70	17.03	0.16
Reach-1	12.4*	20.00	98.22	99.51	98.81	99.53	0.000977	1.21	16.51	18.62	0.23
Reach-1	12.4*	30.00	98.22	99.66	98.95	99.70	0.001441	1.53	19.61	20.86	0.28
Reach-1	12.4*	40.00	98.22	99.80	99.07	99.85	0.001818	1.77	22.56	22.87	0.31
Reach-1	12.4*	50.00	98.22	99.92	99.17	99.98	0.002082	1.97	25.35	24.25	0.34
Reach-1	12.4*	60.00	98.22	100.03	99.27	100.10	0.002221	2.14	28.09	25.00	0.36
Reach-1	12.4*	70.00	98.22	100.13	99.35	100.21	0.002324	2.28	30.68	25.55	0.37
Reach-1	12.4*	80.00	98.22	100.23	99.44	100.32	0.002403	2.41	33.18	26.00	0.38
Reach-1	12.4*	90.00	98.22	100.32	99.51	100.42	0.002472	2.53	35.57	26.43	0.38
Reach-1	12.4*	100.00	98.22	100.41	99.60	100.51	0.002531	2.64	37.89	26.83	0.39
Reach-1	12.4*	200.00	98.22	101.11	100.16	101.29	0.002759	3.44	63.29	76.68	0.43
Reach-1	12.4*	500.00	98.22	102.01	101.55	102.25	0.002888	4.52	215.96	260.38	0.47
Reach-1	12.4*	750.00	98.22	102.41	102.04	102.66	0.002985	5.00	335.36	340.90	0.49
Reach-1	12.4*	1000.00	98.22	102.69	102.33	102.96	0.003126	5.41	439.98	396.13	0.50
Reach-1	12.4*	1500.00	98.22	103.09	102.80	103.36	0.003282	5.94	597.10	398.00	0.53
Reach-1	12.2*	10.00	98.42	99.27	98.86	99.29	0.001224	0.99	10.10	18.43	0.24
Reach-1	12.2*	20.00	98.42	99.47	99.01	99.50	0.002024	1.42	14.10	21.89	0.31
Reach-1	12.2*	30.00	98.42	99.62	99.14	99.66	0.002483	1.72	17.47	23.71	0.35
Reach-1	12.2*	40.00	98.42	99.74	99.24	99.80	0.002688	1.95	20.54	24.45	0.37
Reach-1	12.2*	50.00	98.42	99.86	99.34	99.93	0.002819	2.14	23.31	24.78	0.39
Reach-1	12.2*	60.00	98.42	99.96	99.43	100.05	0.002881	2.31	26.01	25.09	0.40

Reach-1	12.2*	70.00	98.42	100.06	99.51	100.16	0.002938	2.45	28.53	25.38	0.41
Reach-1	12.2*	80.00	98.42	100.16	99.58	100.26	0.002982	2.58	30.95	25.66	0.41
Reach-1	12.2*	90.00	98.42	100.25	99.64	100.36	0.003023	2.71	33.25	25.92	0.42
Reach-1	12.2*	100.00	98.42	100.33	99.70	100.46	0.003058	2.82	35.47	26.17	0.43
Reach-1	12.2*	200.00	98.42	101.02	100.18	101.23	0.003215	3.67	59.35	73.92	0.46
Reach-1	12.2*	500.00	98.42	101.93	101.57	102.19	0.003176	4.71	211.68	259.15	0.49
Reach-1	12.2*	750.00	98.42	102.33	102.01	102.60	0.003244	5.18	329.60	339.00	0.50
Reach-1	12.2*	1000.00	98.42	102.61	102.29	102.89	0.003353	5.57	434.19	394.27	0.52
Reach-1	12.2*	1500.00	98.42	103.01	102.74	103.29	0.003429	6.05	593.77	397.00	0.54
Reach-1	12	10.00	98.62	99.18	99.07	99.23	0.009185	1.76	5.68	19.90	0.58
Reach-1	12	20.00	98.62	99.36	99.21	99.43	0.007996	2.08	9.62	23.61	0.57
Reach-1	12	30.00	98.62	99.50	99.32	99.58	0.006890	2.32	12.91	23.86	0.56
Reach-1	12	40.00	98.62	99.62	99.39	99.72	0.006227	2.51	15.91	24.08	0.55
Reach-1	12	50.00	98.62	99.73	99.46	99.84	0.005916	2.69	18.56	24.27	0.54
Reach-1	12	60.00	98.62	99.84	99.53	99.96	0.005551	2.83	21.21	24.46	0.54
Reach-1	12	70.00	98.62	99.94	99.60	100.08	0.005333	2.96	23.65	24.63	0.53
Reach-1	12	80.00	98.62	100.03	99.66	100.18	0.005169	3.08	25.98	24.80	0.53
Reach-1	12	90.00	98.62	100.12	99.72	100.28	0.005061	3.20	28.16	24.95	0.53
Reach-1	12	100.00	98.62	100.21	99.77	100.38	0.004977	3.30	30.26	25.10	0.53
Reach-1	12	200.00	98.62	100.87	100.26	101.14	0.004825	4.22	49.40	55.75	0.55
Reach-1	12	500.00	98.62	101.79	101.60	102.12	0.004359	5.28	186.84	242.59	0.56
Reach-1	12	750.00	98.62	102.21	102.00	102.52	0.004053	5.60	306.60	327.75	0.55
Reach-1	12	1000.00	98.62	102.52	102.26	102.81	0.003917	5.85	417.49	390.37	0.55
Reach-1	12	1500.00	98.62	102.94	102.68	103.22	0.003761	6.19	583.86	396.00	0.55
Reach-1	11.8*	10.00	98.37	98.92	98.84	99.00	0.013239	2.25	4.44	14.15	0.71
Reach-1	11.8*	20.00	98.37	99.13	99.01	99.23	0.011096	2.54	7.87	18.24	0.68
Reach-1	11.8*	30.00	98.37	99.32	99.14	99.42	0.008879	2.59	11.56	21.97	0.63
Reach-1	11.8*	40.00	98.37	99.48	99.24	99.58	0.007303	2.60	15.37	25.06	0.59
Reach-1	11.8*	50.00	98.37	99.61	99.33	99.72	0.005978	2.66	18.76	25.28	0.55
Reach-1	11.8*	60.00	98.37	99.74	99.42	99.85	0.005230	2.74	21.90	25.49	0.52
Reach-1	11.8*	70.00	98.37	99.85	99.48	99.97	0.004870	2.84	24.66	25.66	0.51
Reach-1	11.8*	80.00	98.37	99.95	99.54	100.08	0.004634	2.94	27.22	25.83	0.50
Reach-1	11.8*	90.00	98.37	100.04	99.60	100.18	0.004490	3.04	29.60	25.98	0.50
Reach-1	11.8*	100.00	98.37	100.12	99.65	100.28	0.004386	3.14	31.87	26.13	0.50
Reach-1	11.8*	200.00	98.37	100.80	100.12	101.04	0.004227	4.01	51.91	56.50	0.52
Reach-1	11.8*	500.00	98.37	101.71	101.47	102.03	0.004079	5.15	187.71	241.28	0.55
Reach-1	11.8*	750.00	98.37	102.12	101.88	102.43	0.003892	5.52	305.63	325.57	0.55
Reach-1	11.8*	1000.00	98.37	102.43	102.16	102.73	0.003834	5.82	413.82	387.08	0.55
Reach-1	11.8*	1500.00	98.37	102.85	102.60	103.14	0.003705	6.18	581.66	396.66	0.55
Reach-1	11.6*	10.00	98.11	98.71	98.58	98.78	0.009272	2.11	4.75	12.76	0.61
Reach-1	11.6*	20.00	98.11	98.97	98.76	99.06	0.007034	2.36	8.46	15.48	0.56
Reach-1	11.6*	30.00	98.11	99.17	98.90	99.27	0.006555	2.54	11.80	18.27	0.56
Reach-1	11.6*	40.00	98.11	99.35	99.01	99.45	0.006077	2.62	15.28	21.40	0.55
Reach-1	11.6*	50.00	98.11	99.50	99.13	99.61	0.005618	2.66	18.77	24.13	0.53
Reach-1	11.6*	60.00	98.11	99.64	99.23	99.75	0.005183	2.69	22.28	26.47	0.52
Reach-1	11.6*	70.00	98.11	99.76	99.32	99.87	0.004587	2.75	25.47	26.67	0.50
Reach-1	11.6*	80.00	98.11	99.86	99.39	99.99	0.004255	2.82	28.33	26.84	0.48
Reach-1	11.6*	90.00	98.11	99.96	99.47	100.09	0.004069	2.91	30.93	27.00	0.48
Reach-1	11.6*	100.00	98.11	100.05	99.53	100.19	0.003941	3.00	33.38	27.14	0.48
Reach-1	11.6*	200.00	98.11	100.73	100.01	100.96	0.003745	3.81	54.68	59.24	0.49
Reach-1	11.6*	500.00	98.11	101.64	101.35	101.94	0.003778	4.98	191.30	242.83	0.53
Reach-1	11.6*	750.00	98.11	102.05	101.80	102.35	0.003681	5.40	308.79	326.58	0.53
Reach-1	11.6*	1000.00	98.11	102.36	102.07	102.65	0.003613	5.69	419.74	389.48	0.54
Reach-1	11.6*	1500.00	98.11	102.77	102.52	103.06	0.003597	6.11	583.67	397.34	0.55
Reach-1	11.4*	10.00	97.86	98.64	98.33	98.67	0.002812	1.45	6.92	13.25	0.35

Reach-1	11.4*	20.00	97.86	98.90	98.51	98.95	0.003267	1.88	10.64	15.29	0.40
Reach-1	11.4*	30.00	97.86	99.09	98.66	99.17	0.003528	2.18	13.76	16.71	0.42
Reach-1	11.4*	40.00	97.86	99.26	98.78	99.35	0.003922	2.39	16.74	19.15	0.45
Reach-1	11.4*	50.00	97.86	99.41	98.89	99.51	0.004133	2.53	19.78	21.63	0.47
Reach-1	11.4*	60.00	97.86	99.55	98.99	99.65	0.004165	2.62	22.92	23.92	0.47
Reach-1	11.4*	70.00	97.86	99.67	99.08	99.79	0.004143	2.69	26.03	26.00	0.47
Reach-1	11.4*	80.00	97.86	99.78	99.18	99.90	0.004113	2.76	29.03	27.78	0.48
Reach-1	11.4*	90.00	97.86	99.89	99.27	100.01	0.003857	2.82	31.88	27.95	0.47
Reach-1	11.4*	100.00	97.86	99.98	99.35	100.11	0.003693	2.90	34.53	28.11	0.46
Reach-1	11.4*	200.00	97.86	100.68	99.91	100.88	0.003421	3.66	57.21	62.60	0.47
Reach-1	11.4*	500.00	97.86	101.58	101.23	101.86	0.003521	4.82	195.91	245.29	0.51
Reach-1	11.4*	750.00	97.86	101.99	101.69	102.27	0.003491	5.26	313.14	328.19	0.52
Reach-1	11.4*	1000.00	97.86	102.29	101.98	102.58	0.003465	5.58	423.57	390.51	0.53
Reach-1	11.4*	1500.00	97.86	102.70	102.44	102.98	0.003508	6.04	585.87	398.00	0.54
Reach-1	11.2*	10.00	97.60	98.62	98.06	98.64	0.000960	1.02	9.79	13.91	0.21
Reach-1	11.2*	20.00	97.60	98.87	98.25	98.90	0.001543	1.48	13.48	15.54	0.28
Reach-1	11.2*	30.00	97.60	99.06	98.41	99.11	0.001952	1.82	16.52	16.71	0.32
Reach-1	11.2*	40.00	97.60	99.22	98.54	99.28	0.002310	2.08	19.26	18.03	0.35
Reach-1	11.2*	50.00	97.60	99.36	98.65	99.44	0.002712	2.28	21.93	20.16	0.39
Reach-1	11.2*	60.00	97.60	99.49	98.76	99.58	0.002976	2.43	24.72	22.20	0.41
Reach-1	11.2*	70.00	97.60	99.61	98.86	99.71	0.003160	2.55	27.50	24.06	0.42
Reach-1	11.2*	80.00	97.60	99.72	98.95	99.83	0.003307	2.65	30.18	25.73	0.43
Reach-1	11.2*	90.00	97.60	99.82	99.03	99.94	0.003398	2.74	32.90	27.31	0.44
Reach-1	11.2*	100.00	97.60	99.92	99.11	100.04	0.003469	2.81	35.57	28.79	0.45
Reach-1	11.2*	200.00	97.60	100.62	99.79	100.81	0.003150	3.52	60.24	68.78	0.45
Reach-1	11.2*	500.00	97.60	101.53	101.11	101.79	0.003201	4.61	205.37	251.74	0.49
Reach-1	11.2*	750.00	97.60	101.93	101.59	102.20	0.003219	5.06	324.05	333.67	0.50
Reach-1	11.2*	1000.00	97.60	102.24	101.88	102.50	0.003233	5.39	434.74	394.35	0.51
Reach-1	11.2*	1500.00	97.60	102.64	102.35	102.91	0.003328	5.88	595.40	398.66	0.52
Reach-1	11.*	10.00	97.35	98.61	97.79	98.62	0.000417	0.78	12.86	14.49	0.15
Reach-1	11.*	20.00	97.35	98.86	97.99	98.88	0.000814	1.21	16.56	15.85	0.21
Reach-1	11.*	30.00	97.35	99.04	98.15	99.08	0.001147	1.53	19.56	16.84	0.25
Reach-1	11.*	40.00	97.35	99.19	98.29	99.24	0.001428	1.80	22.21	17.68	0.28
Reach-1	11.*	50.00	97.35	99.33	98.41	99.39	0.001761	2.03	24.64	19.21	0.32
Reach-1	11.*	60.00	97.35	99.45	98.52	99.53	0.002064	2.21	27.16	21.03	0.34
Reach-1	11.*	70.00	97.35	99.57	98.62	99.65	0.002313	2.36	29.66	22.67	0.36
Reach-1	11.*	80.00	97.35	99.67	98.71	99.77	0.002530	2.49	32.07	24.15	0.38
Reach-1	11.*	90.00	97.35	99.77	98.80	99.87	0.002701	2.61	34.51	25.56	0.40
Reach-1	11.*	100.00	97.35	99.86	98.88	99.97	0.002847	2.71	36.91	26.88	0.41
Reach-1	11.*	200.00	97.35	100.57	99.61	100.75	0.002979	3.41	62.73	73.43	0.44
Reach-1	11.*	500.00	97.35	101.48	101.01	101.72	0.002978	4.43	213.35	257.62	0.47
Reach-1	11.*	750.00	97.35	101.88	101.49	102.13	0.003021	4.89	333.62	339.19	0.48
Reach-1	11.*	1000.00	97.35	102.18	101.79	102.43	0.003054	5.22	444.83	397.69	0.49
Reach-1	11.*	1500.00	97.35	102.58	102.26	102.84	0.003187	5.73	604.01	399.34	0.51
Reach-1	10.8	10.00	97.09	98.61	97.52	98.62	0.000217	0.63	15.97	15.00	0.11
Reach-1	10.8	20.00	97.09	98.85	97.73	98.86	0.000479	1.01	19.70	16.18	0.16
Reach-1	10.8	30.00	97.09	99.03	97.90	99.06	0.000726	1.32	22.69	17.06	0.20
Reach-1	10.8	40.00	97.09	99.18	98.04	99.22	0.000953	1.58	25.30	17.80	0.23
Reach-1	10.8	50.00	97.09	99.31	98.16	99.36	0.001177	1.81	27.63	18.58	0.26
Reach-1	10.8	60.00	97.09	99.43	98.28	99.49	0.001445	2.00	29.95	20.22	0.29
Reach-1	10.8	70.00	97.09	99.54	98.38	99.61	0.001687	2.17	32.25	21.71	0.31
Reach-1	10.8	80.00	97.09	99.63	98.48	99.72	0.001912	2.32	34.44	23.05	0.33
Reach-1	10.8	90.00	97.09	99.73	98.57	99.82	0.002107	2.45	36.67	24.33	0.35
Reach-1	10.8	100.00	97.09	99.82	98.66	99.92	0.002284	2.57	38.86	25.53	0.37
Reach-1	10.8	200.00	97.09	100.52	99.37	100.69	0.002868	3.32	65.08	78.18	0.43
Reach-1	10.8	500.00	97.09	101.43	100.91	101.65	0.002792	4.27	221.62	263.49	0.45

Reach-1	10.8	750.00	97.09	101.84	101.40	102.06	0.002850	4.72	343.50	344.55	0.47
Reach-1	10.8	1000.00	97.09	102.13	101.70	102.37	0.002895	5.05	455.06	400.00	0.48
Reach-1	10.8	1500.00	97.09	102.53	102.18	102.77	0.003067	5.58	612.49	400.00	0.50
Reach-1	10.6*	10.00	97.29	98.60	97.74	98.61	0.000350	0.72	13.80	15.23	0.13
Reach-1	10.6*	20.00	97.29	98.83	97.94	98.85	0.000718	1.14	17.47	16.57	0.20
Reach-1	10.6*	30.00	97.29	99.00	98.10	99.04	0.001046	1.47	20.40	17.56	0.24
Reach-1	10.6*	40.00	97.29	99.15	98.23	99.19	0.001427	1.74	23.02	19.51	0.28
Reach-1	10.6*	50.00	97.29	99.27	98.35	99.33	0.001779	1.96	25.52	21.32	0.32
Reach-1	10.6*	60.00	97.29	99.38	98.46	99.45	0.002067	2.14	28.05	23.01	0.34
Reach-1	10.6*	70.00	97.29	99.49	98.55	99.57	0.002308	2.29	30.54	24.56	0.36
Reach-1	10.6*	80.00	97.29	99.58	98.64	99.67	0.002526	2.43	32.92	25.95	0.38
Reach-1	10.6*	90.00	97.29	99.67	98.73	99.77	0.002696	2.55	35.35	27.29	0.39
Reach-1	10.6*	100.00	97.29	99.76	98.81	99.87	0.002844	2.65	37.72	28.55	0.41
Reach-1	10.6*	200.00	97.29	100.45	99.52	100.63	0.002826	3.38	64.28	78.05	0.43
Reach-1	10.6*	500.00	97.29	101.37	100.89	101.60	0.002826	4.38	219.97	262.96	0.46
Reach-1	10.6*	750.00	97.29	101.77	101.36	102.01	0.002898	4.84	341.18	343.85	0.47
Reach-1	10.6*	1000.00	97.29	102.06	101.66	102.30	0.002997	5.21	448.84	398.62	0.49
Reach-1	10.6*	1500.00	97.29	102.45	102.13	102.71	0.003161	5.74	606.04	399.00	0.51
Reach-1	10.4*	10.00	97.50	98.59	97.97	98.60	0.000672	0.88	11.39	15.64	0.18
Reach-1	10.4*	20.00	97.50	98.81	98.15	98.83	0.001264	1.34	14.98	17.56	0.25
Reach-1	10.4*	30.00	97.50	98.97	98.30	99.01	0.001858	1.67	18.01	20.22	0.31
Reach-1	10.4*	40.00	97.50	99.10	98.42	99.16	0.002330	1.92	20.85	22.44	0.35
Reach-1	10.4*	50.00	97.50	99.21	98.53	99.28	0.002714	2.13	23.53	24.34	0.38
Reach-1	10.4*	60.00	97.50	99.32	98.63	99.40	0.002973	2.28	26.28	26.16	0.40
Reach-1	10.4*	70.00	97.50	99.42	98.73	99.51	0.003150	2.41	29.03	27.78	0.42
Reach-1	10.4*	80.00	97.50	99.52	98.82	99.62	0.003133	2.53	31.60	27.94	0.42
Reach-1	10.4*	90.00	97.50	99.61	98.91	99.72	0.003104	2.64	34.13	28.09	0.42
Reach-1	10.4*	100.00	97.50	99.69	98.99	99.81	0.003102	2.74	36.47	28.23	0.43
Reach-1	10.4*	200.00	97.50	100.38	99.55	100.57	0.003027	3.52	61.67	75.67	0.45
Reach-1	10.4*	500.00	97.50	101.29	100.87	101.54	0.003008	4.54	215.44	260.94	0.47
Reach-1	10.4*	750.00	97.50	101.69	101.33	101.94	0.003083	5.01	334.56	341.17	0.49
Reach-1	10.4*	1000.00	97.50	101.97	101.62	102.23	0.003235	5.42	437.67	395.86	0.51
Reach-1	10.4*	1500.00	97.50	102.37	102.08	102.64	0.003326	5.91	597.70	398.00	0.53
Reach-1	10.2*	10.00	97.70	98.56	98.17	98.58	0.001702	1.13	8.89	17.10	0.28
Reach-1	10.2*	20.00	97.70	98.76	98.35	98.80	0.002743	1.58	12.67	20.93	0.36
Reach-1	10.2*	30.00	97.70	98.90	98.48	98.96	0.003403	1.88	15.93	23.72	0.41
Reach-1	10.2*	40.00	97.70	99.03	98.60	99.10	0.003740	2.10	19.03	25.78	0.43
Reach-1	10.2*	50.00	97.70	99.14	98.70	99.22	0.003730	2.29	21.87	25.97	0.44
Reach-1	10.2*	60.00	97.70	99.24	98.79	99.34	0.003658	2.43	24.65	26.14	0.44
Reach-1	10.2*	70.00	97.70	99.34	98.87	99.45	0.003616	2.57	27.24	26.30	0.45
Reach-1	10.2*	80.00	97.70	99.43	98.94	99.55	0.003606	2.70	29.64	26.45	0.45
Reach-1	10.2*	90.00	97.70	99.52	99.01	99.65	0.003570	2.81	32.02	26.60	0.45
Reach-1	10.2*	100.00	97.70	99.61	99.07	99.74	0.003574	2.92	34.21	26.74	0.46
Reach-1	10.2*	200.00	97.70	100.29	99.52	100.50	0.003521	3.76	57.51	71.42	0.48
Reach-1	10.2*	500.00	97.70	101.21	100.87	101.48	0.003293	4.73	210.77	259.18	0.49
Reach-1	10.2*	750.00	97.70	101.61	101.30	101.87	0.003340	5.19	328.35	338.81	0.51
Reach-1	10.2*	1000.00	97.70	101.89	101.57	102.17	0.003414	5.56	434.08	394.48	0.52
Reach-1	10.2*	1500.00	97.70	102.30	102.02	102.57	0.003475	6.03	593.54	397.00	0.54
Reach-1	10	10.00	97.90	98.46	98.35	98.51	0.009268	1.77	5.66	19.87	0.58
Reach-1	10	20.00	97.90	98.64	98.50	98.71	0.007882	2.07	9.66	23.62	0.57
Reach-1	10	30.00	97.90	98.78	98.60	98.86	0.006766	2.31	12.98	23.86	0.55
Reach-1	10	40.00	97.90	98.90	98.67	99.00	0.006289	2.52	15.86	24.07	0.55
Reach-1	10	50.00	97.90	99.01	98.74	99.12	0.005961	2.70	18.52	24.27	0.54
Reach-1	10	60.00	97.90	99.12	98.81	99.24	0.005562	2.83	21.20	24.46	0.54
Reach-1	10	70.00	97.90	99.22	98.88	99.36	0.005333	2.96	23.65	24.63	0.53

Reach-1	10	80.00	97.90	99.31	98.94	99.46	0.005232	3.09	25.88	24.79	0.53
Reach-1	10	90.00	97.90	99.40	98.99	99.56	0.005088	3.20	28.12	24.95	0.53
Reach-1	10	100.00	97.90	99.48	99.05	99.65	0.005053	3.32	30.12	25.09	0.53
Reach-1	10	200.00	97.90	100.14	99.53	100.42	0.004888	4.24	49.03	54.39	0.56
Reach-1	10	500.00	97.90	101.07	100.87	101.40	0.004342	5.27	187.30	242.97	0.56
Reach-1	10	750.00	97.90	101.49	101.28	101.80	0.004038	5.59	307.23	328.14	0.55
Reach-1	10	1000.00	97.90	101.79	101.54	102.09	0.003969	5.88	414.80	388.97	0.56
Reach-1	10	1500.00	97.90	102.21	101.96	102.49	0.003813	6.23	580.93	396.00	0.56

Design Channel: Bankfull Discharge = 150 cfs; Slope = 0.0041 ft/ft

Profile Output Table - Standard Table 1
HEC-RAS Plan: q150sp41 River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 673
Plans = 1
Profiles = 15

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	20	10.00	102.40	102.83	102.75	102.88	0.009341	1.71	5.84	21.50	0.58
Reach-1	20	20.00	102.40	103.01	102.86	103.07	0.007489	2.10	9.54	21.83	0.56
Reach-1	20	30.00	102.40	103.12	102.95	103.22	0.007938	2.49	12.03	22.06	0.59
Reach-1	20	40.00	102.40	103.22	103.03	103.34	0.008152	2.80	14.26	22.26	0.62
Reach-1	20	50.00	102.40	103.32	103.11	103.46	0.008049	3.04	16.45	22.45	0.63
Reach-1	20	60.00	102.40	103.41	103.18	103.57	0.007973	3.24	18.49	22.63	0.63
Reach-1	20	70.00	102.40	103.49	103.25	103.68	0.007866	3.42	20.46	22.80	0.64
Reach-1	20	80.00	102.40	103.58	103.31	103.78	0.007784	3.58	22.32	22.96	0.64
Reach-1	20	90.00	102.40	103.65	103.37	103.87	0.007701	3.73	24.13	23.12	0.64
Reach-1	20	100.00	102.40	103.73	103.44	103.96	0.007634	3.87	25.87	23.27	0.65
Reach-1	20	200.00	102.40	104.34	103.94	104.70	0.007159	4.89	46.08	72.24	0.66
Reach-1	20	500.00	102.40	105.20	105.12	105.56	0.005544	5.67	184.67	247.84	0.63
Reach-1	20	750.00	102.40	105.60	105.45	105.92	0.005045	5.95	297.92	327.65	0.61
Reach-1	20	1000.00	102.40	105.89	105.70	106.20	0.004862	6.22	400.88	386.15	0.61
Reach-1	20	1500.00	102.40	106.29	106.08	106.58	0.004534	6.51	561.59	394.00	0.60
Reach-1	19.8*	10.00	102.07	102.58	102.51	102.66	0.013732	2.25	4.44	14.53	0.72
Reach-1	19.8*	20.00	102.07	102.77	102.68	102.87	0.013989	2.59	7.73	20.78	0.75
Reach-1	19.8*	30.00	102.07	102.92	102.80	103.03	0.010361	2.65	11.34	23.41	0.67
Reach-1	19.8*	40.00	102.07	103.05	102.88	103.17	0.008471	2.78	14.40	23.64	0.63
Reach-1	19.8*	50.00	102.07	103.17	102.96	103.30	0.007618	2.93	17.08	23.84	0.61
Reach-1	19.8*	60.00	102.07	103.27	103.02	103.41	0.007207	3.08	19.46	24.01	0.60
Reach-1	19.8*	70.00	102.07	103.36	103.09	103.52	0.006875	3.22	21.75	24.18	0.60
Reach-1	19.8*	80.00	102.07	103.45	103.15	103.62	0.006659	3.35	23.88	24.33	0.60
Reach-1	19.8*	90.00	102.07	103.53	103.21	103.72	0.006484	3.47	25.93	24.48	0.59
Reach-1	19.8*	100.00	102.07	103.61	103.26	103.81	0.006358	3.59	27.88	24.62	0.59
Reach-1	19.8*	200.00	102.07	104.24	103.75	104.56	0.005894	4.53	48.75	70.60	0.61
Reach-1	19.8*	500.00	102.07	105.08	104.98	105.44	0.005407	5.64	177.93	239.43	0.62
Reach-1	19.8*	750.00	102.07	105.47	105.34	105.82	0.005004	5.97	288.87	319.81	0.61
Reach-1	19.8*	1000.00	102.07	105.76	105.58	106.10	0.004859	6.26	390.19	378.59	0.61
Reach-1	19.8*	1500.00	102.07	106.18	105.99	106.49	0.004517	6.55	555.14	395.00	0.60
Reach-1	19.6*	10.00	101.74	102.24	102.19	102.35	0.017450	2.63	3.80	11.72	0.81
Reach-1	19.6*	20.00	101.74	102.50	102.37	102.62	0.011428	2.81	7.12	14.41	0.70
Reach-1	19.6*	30.00	101.74	102.69	102.51	102.82	0.010344	2.94	10.20	17.88	0.69
Reach-1	19.6*	40.00	101.74	102.87	102.64	103.00	0.009013	2.91	13.77	22.15	0.65
Reach-1	19.6*	50.00	101.74	103.02	102.76	103.15	0.007755	2.89	17.33	25.13	0.61
Reach-1	19.6*	60.00	101.74	103.14	102.85	103.27	0.006573	2.94	20.42	25.34	0.58
Reach-1	19.6*	70.00	101.74	103.25	102.94	103.39	0.005941	3.02	23.19	25.52	0.56

Reach-1	19.6*	80.00	101.74	103.34	103.00	103.50	0.005609	3.12	25.66	25.68	0.55
Reach-1	19.6*	90.00	101.74	103.44	103.06	103.60	0.005375	3.21	27.99	25.83	0.54
Reach-1	19.6*	100.00	101.74	103.52	103.12	103.69	0.005224	3.31	30.18	25.97	0.54
Reach-1	19.6*	200.00	101.74	104.17	103.58	104.44	0.004799	4.18	52.74	73.35	0.55
Reach-1	19.6*	500.00	101.74	105.00	104.85	105.34	0.004797	5.38	182.34	240.80	0.59
Reach-1	19.6*	750.00	101.74	105.38	105.22	105.72	0.004677	5.83	289.88	318.80	0.59
Reach-1	19.6*	1000.00	101.74	105.66	105.48	106.00	0.004656	6.18	388.65	376.47	0.60
Reach-1	19.6*	1500.00	101.74	106.08	105.90	106.40	0.004387	6.50	554.51	396.00	0.60
Reach-1	19.4*	10.00	101.40	102.17	101.86	102.21	0.002949	1.48	6.75	12.85	0.36
Reach-1	19.4*	20.00	101.40	102.42	102.05	102.48	0.003700	1.97	10.14	14.81	0.42
Reach-1	19.4*	30.00	101.40	102.60	102.20	102.68	0.004253	2.32	12.94	16.42	0.46
Reach-1	19.4*	40.00	101.40	102.76	102.33	102.86	0.004798	2.52	15.87	19.47	0.49
Reach-1	19.4*	50.00	101.40	102.91	102.44	103.02	0.005011	2.64	18.93	22.37	0.51
Reach-1	19.4*	60.00	101.40	103.04	102.54	103.15	0.005064	2.73	21.98	24.94	0.51
Reach-1	19.4*	70.00	101.40	103.15	102.65	103.28	0.004927	2.80	25.03	26.82	0.51
Reach-1	19.4*	80.00	101.40	103.26	102.75	103.39	0.004553	2.87	27.88	27.00	0.50
Reach-1	19.4*	90.00	101.40	103.36	102.83	103.49	0.004320	2.95	30.51	27.16	0.49
Reach-1	19.4*	100.00	101.40	103.45	102.91	103.59	0.004185	3.04	32.92	27.31	0.49
Reach-1	19.4*	200.00	101.40	104.11	103.42	104.34	0.003843	3.83	58.61	81.56	0.50
Reach-1	19.4*	500.00	101.40	104.94	104.70	105.24	0.004029	5.02	194.58	248.29	0.54
Reach-1	19.4*	750.00	101.40	105.31	105.10	105.62	0.004106	5.53	301.93	324.14	0.56
Reach-1	19.4*	1000.00	101.40	105.59	105.36	105.91	0.004199	5.93	399.90	380.38	0.57
Reach-1	19.4*	1500.00	101.40	106.01	105.79	106.31	0.004076	6.32	563.98	397.00	0.58
Reach-1	19.2*	10.00	101.07	102.16	101.52	102.18	0.000734	0.93	10.71	14.17	0.19
Reach-1	19.2*	20.00	101.07	102.40	101.72	102.43	0.001310	1.41	14.23	15.66	0.26
Reach-1	19.2*	30.00	101.07	102.57	101.88	102.62	0.001780	1.76	17.04	16.76	0.31
Reach-1	19.2*	40.00	101.07	102.72	102.01	102.79	0.002303	2.03	19.74	19.12	0.35
Reach-1	19.2*	50.00	101.07	102.86	102.13	102.94	0.002701	2.22	22.51	21.42	0.38
Reach-1	19.2*	60.00	101.07	102.98	102.23	103.07	0.002996	2.38	25.24	23.47	0.40
Reach-1	19.2*	70.00	101.07	103.09	102.33	103.19	0.003199	2.50	28.00	25.37	0.42
Reach-1	19.2*	80.00	101.07	103.20	102.42	103.30	0.003332	2.60	30.78	27.16	0.43
Reach-1	19.2*	90.00	101.07	103.30	102.51	103.41	0.003365	2.68	33.54	28.41	0.44
Reach-1	19.2*	100.00	101.07	103.39	102.59	103.51	0.003275	2.77	36.15	28.59	0.43
Reach-1	19.2*	200.00	101.07	104.07	103.27	104.26	0.003072	3.51	65.25	90.38	0.45
Reach-1	19.2*	500.00	101.07	104.89	104.54	105.15	0.003450	4.71	205.67	254.78	0.50
Reach-1	19.2*	750.00	101.07	105.26	104.98	105.54	0.003625	5.25	314.06	329.71	0.53
Reach-1	19.2*	1000.00	101.07	105.53	105.25	105.82	0.003807	5.69	411.00	384.56	0.55
Reach-1	19.2*	1500.00	101.07	105.94	105.70	106.23	0.003807	6.14	572.81	398.00	0.56
Reach-1	19.*	10.00	100.74	102.16	101.18	102.16	0.000270	0.67	14.96	15.20	0.12
Reach-1	19.*	20.00	100.74	102.39	101.39	102.41	0.000582	1.07	18.63	16.48	0.18
Reach-1	19.*	30.00	100.74	102.56	101.55	102.59	0.000879	1.40	21.49	17.41	0.22
Reach-1	19.*	40.00	100.74	102.70	101.69	102.75	0.001209	1.66	24.14	19.20	0.26
Reach-1	19.*	50.00	100.74	102.83	101.81	102.89	0.001519	1.87	26.77	21.16	0.29
Reach-1	19.*	60.00	100.74	102.95	101.92	103.02	0.001790	2.05	29.32	22.89	0.32
Reach-1	19.*	70.00	100.74	103.06	102.03	103.13	0.002014	2.20	31.88	24.50	0.34
Reach-1	19.*	80.00	100.74	103.16	102.12	103.24	0.002198	2.32	34.45	26.02	0.36
Reach-1	19.*	90.00	100.74	103.26	102.20	103.35	0.002350	2.43	37.01	27.44	0.37
Reach-1	19.*	100.00	100.74	103.35	102.29	103.45	0.002477	2.53	39.55	28.79	0.38
Reach-1	19.*	200.00	100.74	104.04	103.01	104.20	0.002494	3.22	72.91	101.31	0.40
Reach-1	19.*	500.00	100.74	104.85	104.39	105.07	0.002930	4.39	220.40	264.51	0.46
Reach-1	19.*	750.00	100.74	105.21	104.85	105.46	0.003202	4.98	328.73	337.38	0.49
Reach-1	19.*	1000.00	100.74	105.47	105.14	105.75	0.003415	5.43	426.89	391.86	0.52
Reach-1	19.*	1500.00	100.74	105.88	105.60	106.15	0.003498	5.92	586.78	399.00	0.53
Reach-1	18.8	10.00	100.41	102.16	100.84	102.16	0.000123	0.51	19.50	16.12	0.08
Reach-1	18.8	20.00	100.41	102.39	101.05	102.40	0.000298	0.86	23.34	17.25	0.13

Reach-1	17.4*	90.00	100.58	102.50	101.85	102.63	0.003472	2.87	31.38	24.92	0.45
Reach-1	17.4*	100.00	100.58	102.59	101.93	102.73	0.003464	2.96	33.77	25.45	0.45
Reach-1	17.4*	200.00	100.58	103.29	102.50	103.50	0.003554	3.76	58.78	78.06	0.48
Reach-1	17.4*	500.00	100.58	104.10	103.85	104.41	0.004003	5.07	189.89	243.75	0.54
Reach-1	17.4*	750.00	100.58	104.48	104.27	104.80	0.004090	5.60	297.01	320.90	0.56
Reach-1	17.4*	1000.00	100.58	104.76	104.54	105.09	0.004184	6.00	395.10	377.99	0.58
Reach-1	17.4*	1500.00	100.58	105.18	104.98	105.49	0.004095	6.42	558.78	397.00	0.58
Reach-1	17.2*	10.00	100.25	101.31	100.65	101.33	0.000581	0.85	11.79	15.28	0.17
Reach-1	17.2*	20.00	100.25	101.55	100.84	101.57	0.001060	1.29	15.50	16.73	0.24
Reach-1	17.2*	30.00	100.25	101.72	100.98	101.76	0.001445	1.62	18.48	17.81	0.28
Reach-1	17.2*	40.00	100.25	101.87	101.11	101.92	0.001786	1.88	21.23	19.16	0.32
Reach-1	17.2*	50.00	100.25	102.01	101.22	102.07	0.002115	2.08	24.01	21.18	0.34
Reach-1	17.2*	60.00	100.25	102.13	101.32	102.21	0.002336	2.24	26.76	22.77	0.36
Reach-1	17.2*	70.00	100.25	102.25	101.42	102.33	0.002457	2.38	29.43	23.79	0.38
Reach-1	17.2*	80.00	100.25	102.35	101.50	102.45	0.002553	2.50	32.02	24.74	0.39
Reach-1	17.2*	90.00	100.25	102.45	101.58	102.56	0.002620	2.60	34.55	25.52	0.39
Reach-1	17.2*	100.00	100.25	102.55	101.66	102.66	0.002680	2.70	37.00	26.24	0.40
Reach-1	17.2*	200.00	100.25	103.25	102.32	103.43	0.002899	3.46	65.69	89.13	0.44
Reach-1	17.2*	500.00	100.25	104.05	103.70	104.32	0.003389	4.72	203.88	252.56	0.50
Reach-1	17.2*	750.00	100.25	104.43	104.14	104.72	0.003562	5.27	312.74	328.29	0.53
Reach-1	17.2*	1000.00	100.25	104.70	104.43	105.00	0.003745	5.72	410.02	383.52	0.55
Reach-1	17.2*	1500.00	100.25	105.11	104.88	105.41	0.003771	6.19	571.62	398.00	0.56
Reach-1	17.*	10.00	99.92	101.31	100.34	101.32	0.000246	0.64	15.54	15.70	0.11
Reach-1	17.*	20.00	99.92	101.54	100.53	101.55	0.000536	1.04	19.25	16.95	0.17
Reach-1	17.*	30.00	99.92	101.71	100.69	101.74	0.000809	1.35	22.19	17.88	0.21
Reach-1	17.*	40.00	99.92	101.85	100.82	101.89	0.001078	1.61	24.85	19.11	0.25
Reach-1	17.*	50.00	99.92	101.98	100.94	102.04	0.001355	1.82	27.50	20.94	0.28
Reach-1	17.*	60.00	99.92	102.10	101.05	102.17	0.001593	1.99	30.12	22.61	0.30
Reach-1	17.*	70.00	99.92	102.22	101.15	102.29	0.001768	2.14	32.72	23.86	0.32
Reach-1	17.*	80.00	99.92	102.32	101.24	102.40	0.001911	2.27	35.27	24.99	0.34
Reach-1	17.*	90.00	99.92	102.42	101.32	102.51	0.002031	2.38	37.79	26.05	0.35
Reach-1	17.*	100.00	99.92	102.51	101.41	102.61	0.002134	2.48	40.27	27.03	0.36
Reach-1	17.*	200.00	99.92	103.21	102.11	103.37	0.002413	3.20	73.03	100.16	0.40
Reach-1	17.*	500.00	99.92	104.02	103.55	104.25	0.002912	4.40	218.57	262.58	0.46
Reach-1	17.*	750.00	99.92	104.38	104.01	104.64	0.003165	4.98	327.95	336.49	0.49
Reach-1	17.*	1000.00	99.92	104.65	104.31	104.93	0.003372	5.44	426.67	391.39	0.52
Reach-1	17.*	1500.00	99.92	105.05	104.78	105.33	0.003470	5.94	586.42	399.00	0.53
Reach-1	16.8	10.00	99.59	101.31	100.02	101.31	0.000131	0.52	19.06	15.98	0.08
Reach-1	16.8	20.00	99.59	101.53	100.23	101.55	0.000319	0.88	22.77	17.09	0.13
Reach-1	16.8	30.00	99.59	101.70	100.40	101.72	0.000515	1.17	25.67	17.91	0.17
Reach-1	16.8	40.00	99.59	101.84	100.54	101.87	0.000721	1.41	28.28	19.05	0.20
Reach-1	16.8	50.00	99.59	101.97	100.66	102.01	0.000946	1.62	30.83	20.80	0.23
Reach-1	16.8	60.00	99.59	102.09	100.78	102.14	0.001154	1.80	33.35	22.39	0.26
Reach-1	16.8	70.00	99.59	102.19	100.88	102.25	0.001340	1.95	35.86	23.87	0.28
Reach-1	16.8	80.00	99.59	102.30	100.98	102.36	0.001505	2.09	38.36	25.26	0.30
Reach-1	16.8	90.00	99.59	102.39	101.07	102.47	0.001650	2.20	40.85	26.57	0.31
Reach-1	16.8	100.00	99.59	102.48	101.16	102.57	0.001777	2.31	43.33	27.82	0.33
Reach-1	16.8	200.00	99.59	103.18	101.87	103.32	0.002065	2.98	80.88	111.80	0.37
Reach-1	16.8	500.00	99.59	103.98	103.41	104.18	0.002532	4.11	234.58	273.25	0.43
Reach-1	16.8	750.00	99.59	104.34	103.90	104.57	0.002826	4.70	345.04	345.46	0.46
Reach-1	16.8	1000.00	99.59	104.61	104.20	104.85	0.003038	5.15	445.33	397.92	0.49
Reach-1	16.8	1500.00	99.59	105.00	104.68	105.26	0.003231	5.70	600.65	400.00	0.51
Reach-1	16.6*	10.00	99.88	101.30	100.29	101.31	0.000202	0.59	16.82	16.63	0.10
Reach-1	16.6*	20.00	99.88	101.52	100.48	101.54	0.000456	0.97	20.59	17.90	0.16
Reach-1	16.6*	30.00	99.88	101.68	100.63	101.71	0.000734	1.27	23.55	19.46	0.20

Reach-1	16.6*	40.00	99.88	101.82	100.76	101.85	0.001020	1.52	26.34	21.43	0.24
Reach-1	16.6*	50.00	99.88	101.94	100.87	101.99	0.001258	1.72	29.08	23.01	0.27
Reach-1	16.6*	60.00	99.88	102.05	100.98	102.11	0.001442	1.89	31.73	24.09	0.29
Reach-1	16.6*	70.00	99.88	102.16	101.08	102.22	0.001599	2.04	34.30	25.11	0.31
Reach-1	16.6*	80.00	99.88	102.26	101.17	102.33	0.001732	2.17	36.82	26.02	0.32
Reach-1	16.6*	90.00	99.88	102.35	101.25	102.43	0.001844	2.29	39.28	26.84	0.33
Reach-1	16.6*	100.00	99.88	102.44	101.33	102.53	0.001944	2.40	41.69	27.62	0.34
Reach-1	16.6*	200.00	99.88	103.13	102.01	103.28	0.002138	3.10	80.16	115.40	0.38
Reach-1	16.6*	500.00	99.88	103.92	103.43	104.13	0.002630	4.26	233.82	274.86	0.44
Reach-1	16.6*	750.00	99.88	104.27	103.88	104.51	0.002927	4.86	343.92	346.61	0.48
Reach-1	16.6*	1000.00	99.88	104.53	104.17	104.79	0.003186	5.34	440.45	396.75	0.51
Reach-1	16.6*	1500.00	99.88	104.91	104.63	105.19	0.003407	5.92	591.95	398.50	0.53
Reach-1	16.4*	10.00	100.18	101.30	100.56	101.30	0.000381	0.71	14.11	17.57	0.14
Reach-1	16.4*	20.00	100.18	101.51	100.73	101.53	0.000799	1.11	17.98	19.82	0.21
Reach-1	16.4*	30.00	100.18	101.66	100.87	101.69	0.001208	1.42	21.17	22.10	0.26
Reach-1	16.4*	40.00	100.18	101.79	100.99	101.83	0.001483	1.66	24.09	23.13	0.29
Reach-1	16.4*	50.00	100.18	101.90	101.09	101.96	0.001688	1.86	26.86	23.87	0.31
Reach-1	16.4*	60.00	100.18	102.01	101.19	102.08	0.001855	2.04	29.46	24.48	0.33
Reach-1	16.4*	70.00	100.18	102.11	101.28	102.19	0.001993	2.19	31.95	25.06	0.34
Reach-1	16.4*	80.00	100.18	102.21	101.36	102.29	0.002111	2.33	34.35	25.60	0.35
Reach-1	16.4*	90.00	100.18	102.30	101.44	102.39	0.002212	2.45	36.68	26.11	0.36
Reach-1	16.4*	100.00	100.18	102.38	101.53	102.48	0.002302	2.57	38.92	26.59	0.37
Reach-1	16.4*	200.00	100.18	103.07	102.08	103.23	0.002422	3.31	77.23	116.54	0.41
Reach-1	16.4*	500.00	100.18	103.85	103.45	104.07	0.002875	4.46	230.52	275.22	0.47
Reach-1	16.4*	750.00	100.18	104.20	103.86	104.45	0.003196	5.08	337.98	345.44	0.50
Reach-1	16.4*	1000.00	100.18	104.45	104.13	104.72	0.003481	5.58	431.90	394.86	0.53
Reach-1	16.4*	1500.00	100.18	104.82	104.57	105.11	0.003689	6.15	581.09	397.00	0.55
Reach-1	16.2*	10.00	100.47	101.28	100.84	101.29	0.001086	0.94	10.66	19.33	0.22
Reach-1	16.2*	20.00	100.47	101.47	101.00	101.50	0.001768	1.36	14.76	22.16	0.29
Reach-1	16.2*	30.00	100.47	101.61	101.12	101.66	0.002180	1.68	17.88	22.66	0.33
Reach-1	16.2*	40.00	100.47	101.73	101.22	101.79	0.002483	1.94	20.62	23.09	0.36
Reach-1	16.2*	50.00	100.47	101.84	101.32	101.91	0.002697	2.16	23.19	23.49	0.38
Reach-1	16.2*	60.00	100.47	101.94	101.41	102.03	0.002869	2.35	25.59	23.85	0.40
Reach-1	16.2*	70.00	100.47	102.04	101.48	102.14	0.003005	2.51	27.87	24.19	0.41
Reach-1	16.2*	80.00	100.47	102.13	101.55	102.24	0.003119	2.66	30.06	24.52	0.42
Reach-1	16.2*	90.00	100.47	102.21	101.61	102.34	0.003212	2.80	32.16	24.83	0.43
Reach-1	16.2*	100.00	100.47	102.29	101.67	102.43	0.003300	2.93	34.18	25.12	0.44
Reach-1	16.2*	200.00	100.47	102.97	102.17	103.17	0.003225	3.70	69.99	112.41	0.46
Reach-1	16.2*	500.00	100.47	103.77	103.47	104.01	0.003317	4.71	226.14	275.47	0.50
Reach-1	16.2*	750.00	100.47	104.11	103.84	104.37	0.003675	5.35	329.19	342.95	0.53
Reach-1	16.2*	1000.00	100.47	104.37	104.10	104.65	0.003839	5.77	426.80	393.43	0.55
Reach-1	16.2*	1500.00	100.47	104.74	104.51	105.03	0.003983	6.30	575.17	395.50	0.57
Reach-1	16	10.00	100.76	101.19	101.11	101.24	0.009342	1.71	5.84	21.50	0.58
Reach-1	16	20.00	100.76	101.37	101.22	101.43	0.007490	2.10	9.54	21.83	0.56
Reach-1	16	30.00	100.76	101.48	101.31	101.58	0.007938	2.49	12.03	22.06	0.59
Reach-1	16	40.00	100.76	101.58	101.39	101.70	0.008152	2.80	14.26	22.26	0.62
Reach-1	16	50.00	100.76	101.68	101.47	101.82	0.008050	3.04	16.45	22.45	0.63
Reach-1	16	60.00	100.76	101.77	101.54	101.93	0.007974	3.24	18.49	22.63	0.63
Reach-1	16	70.00	100.76	101.85	101.61	102.04	0.007867	3.42	20.45	22.80	0.64
Reach-1	16	80.00	100.76	101.94	101.67	102.14	0.007785	3.58	22.32	22.96	0.64
Reach-1	16	90.00	100.76	102.01	101.73	102.23	0.007701	3.73	24.13	23.12	0.64
Reach-1	16	100.00	100.76	102.09	101.80	102.32	0.007635	3.87	25.87	23.27	0.65
Reach-1	16	200.00	100.76	102.70	102.30	103.06	0.007158	4.89	46.08	72.25	0.66
Reach-1	16	500.00	100.76	103.56	103.48	103.92	0.005545	5.67	184.67	247.84	0.63
Reach-1	16	750.00	100.76	103.96	103.81	104.28	0.005046	5.96	297.91	327.64	0.61
Reach-1	16	1000.00	100.76	104.25	104.06	104.56	0.004861	6.22	400.94	386.18	0.61

Reach-1	16	1500.00	100.76	104.65	104.44	104.94	0.004533	6.50	561.63	394.00	0.60
Reach-1	15.8*	10.00	100.43	100.94	100.87	101.02	0.013729	2.25	4.44	14.53	0.72
Reach-1	15.8*	20.00	100.43	101.13	101.04	101.23	0.013986	2.59	7.73	20.78	0.75
Reach-1	15.8*	30.00	100.43	101.28	101.16	101.39	0.010361	2.65	11.34	23.41	0.67
Reach-1	15.8*	40.00	100.43	101.41	101.24	101.53	0.008472	2.78	14.40	23.64	0.63
Reach-1	15.8*	50.00	100.43	101.53	101.32	101.66	0.007620	2.93	17.08	23.84	0.61
Reach-1	15.8*	60.00	100.43	101.63	101.38	101.77	0.007209	3.08	19.46	24.01	0.60
Reach-1	15.8*	70.00	100.43	101.72	101.45	101.88	0.006876	3.22	21.75	24.18	0.60
Reach-1	15.8*	80.00	100.43	101.81	101.51	101.98	0.006660	3.35	23.88	24.33	0.60
Reach-1	15.8*	90.00	100.43	101.89	101.57	102.08	0.006485	3.47	25.93	24.48	0.59
Reach-1	15.8*	100.00	100.43	101.97	101.62	102.17	0.006360	3.59	27.88	24.62	0.59
Reach-1	15.8*	200.00	100.43	102.60	102.11	102.92	0.005892	4.53	48.76	70.63	0.61
Reach-1	15.8*	500.00	100.43	103.44	103.34	103.80	0.005406	5.64	177.94	239.44	0.62
Reach-1	15.8*	750.00	100.43	103.83	103.70	104.18	0.005005	5.97	288.82	319.78	0.61
Reach-1	15.8*	1000.00	100.43	104.12	103.94	104.46	0.004855	6.26	390.31	378.66	0.61
Reach-1	15.8*	1500.00	100.43	104.54	104.35	104.85	0.004515	6.55	555.21	395.00	0.60
Reach-1	15.6*	10.00	100.10	100.60	100.55	100.71	0.017464	2.63	3.80	11.72	0.82
Reach-1	15.6*	20.00	100.10	100.85	100.73	100.98	0.011435	2.81	7.12	14.41	0.70
Reach-1	15.6*	30.00	100.10	101.05	100.87	101.18	0.010351	2.94	10.20	17.87	0.69
Reach-1	15.6*	40.00	100.10	101.23	101.00	101.36	0.009017	2.91	13.77	22.15	0.65
Reach-1	15.6*	50.00	100.10	101.38	101.12	101.51	0.007759	2.89	17.33	25.13	0.61
Reach-1	15.6*	60.00	100.10	101.50	101.21	101.63	0.006576	2.94	20.41	25.34	0.58
Reach-1	15.6*	70.00	100.10	101.61	101.30	101.75	0.005943	3.02	23.19	25.52	0.56
Reach-1	15.6*	80.00	100.10	101.70	101.36	101.86	0.005611	3.12	25.66	25.68	0.55
Reach-1	15.6*	90.00	100.10	101.80	101.42	101.96	0.005377	3.22	27.99	25.83	0.54
Reach-1	15.6*	100.00	100.10	101.88	101.48	102.05	0.005226	3.31	30.17	25.97	0.54
Reach-1	15.6*	200.00	100.10	102.53	101.94	102.80	0.004798	4.18	52.75	73.38	0.55
Reach-1	15.6*	500.00	100.10	103.36	103.21	103.70	0.004797	5.38	182.35	240.80	0.59
Reach-1	15.6*	750.00	100.10	103.74	103.58	104.08	0.004680	5.83	289.79	318.75	0.59
Reach-1	15.6*	1000.00	100.10	104.02	103.84	104.36	0.004650	6.17	388.89	376.60	0.60
Reach-1	15.6*	1500.00	100.10	104.45	104.26	104.76	0.004384	6.50	554.64	396.00	0.60
Reach-1	15.4*	10.00	99.76	100.53	100.22	100.57	0.002951	1.48	6.75	12.85	0.36
Reach-1	15.4*	20.00	99.76	100.78	100.41	100.84	0.003702	1.97	10.14	14.81	0.42
Reach-1	15.4*	30.00	99.76	100.96	100.56	101.04	0.004256	2.32	12.93	16.41	0.46
Reach-1	15.4*	40.00	99.76	101.12	100.69	101.22	0.004801	2.52	15.87	19.47	0.49
Reach-1	15.4*	50.00	99.76	101.27	100.80	101.38	0.005013	2.64	18.93	22.37	0.51
Reach-1	15.4*	60.00	99.76	101.40	100.90	101.51	0.005066	2.73	21.98	24.93	0.51
Reach-1	15.4*	70.00	99.76	101.51	101.01	101.64	0.004929	2.80	25.03	26.82	0.51
Reach-1	15.4*	80.00	99.76	101.62	101.11	101.75	0.004555	2.87	27.88	27.00	0.50
Reach-1	15.4*	90.00	99.76	101.72	101.19	101.85	0.004322	2.95	30.51	27.16	0.49
Reach-1	15.4*	100.00	99.76	101.81	101.27	101.95	0.004187	3.04	32.92	27.31	0.49
Reach-1	15.4*	200.00	99.76	102.47	101.78	102.70	0.003842	3.83	58.62	81.59	0.50
Reach-1	15.4*	500.00	99.76	103.30	103.06	103.60	0.004029	5.02	194.59	248.30	0.54
Reach-1	15.4*	750.00	99.76	103.67	103.46	103.98	0.004108	5.53	301.82	324.07	0.56
Reach-1	15.4*	1000.00	99.76	103.95	103.72	104.27	0.004192	5.92	400.22	380.55	0.57
Reach-1	15.4*	1500.00	99.76	104.37	104.15	104.67	0.004072	6.32	564.15	397.00	0.58
Reach-1	15.2*	10.00	99.43	100.52	99.88	100.54	0.000734	0.93	10.71	14.16	0.19
Reach-1	15.2*	20.00	99.43	100.76	100.08	100.79	0.001311	1.41	14.23	15.66	0.26
Reach-1	15.2*	30.00	99.43	100.93	100.24	100.98	0.001781	1.76	17.03	16.76	0.31
Reach-1	15.2*	40.00	99.43	101.08	100.37	101.15	0.002304	2.03	19.74	19.12	0.35
Reach-1	15.2*	50.00	99.43	101.22	100.49	101.30	0.002702	2.22	22.50	21.42	0.38
Reach-1	15.2*	60.00	99.43	101.34	100.59	101.43	0.002997	2.38	25.23	23.47	0.40
Reach-1	15.2*	70.00	99.43	101.45	100.69	101.55	0.003200	2.50	27.99	25.37	0.42
Reach-1	15.2*	80.00	99.43	101.56	100.78	101.66	0.003334	2.60	30.78	27.16	0.43
Reach-1	15.2*	90.00	99.43	101.66	100.87	101.77	0.003367	2.68	33.54	28.41	0.44

Reach-1	15.2*	100.00	99.43	101.75	100.95	101.87	0.003276	2.77	36.14	28.59	0.43
Reach-1	15.2*	200.00	99.43	102.43	101.63	102.62	0.003071	3.51	65.27	90.41	0.45
Reach-1	15.2*	500.00	99.43	103.25	102.90	103.51	0.003450	4.71	205.68	254.78	0.50
Reach-1	15.2*	750.00	99.43	103.62	103.34	103.90	0.003628	5.25	313.93	329.63	0.53
Reach-1	15.2*	1000.00	99.43	103.89	103.61	104.18	0.003800	5.69	411.40	384.77	0.55
Reach-1	15.2*	1500.00	99.43	104.30	104.06	104.59	0.003803	6.14	573.03	398.00	0.56
Reach-1	15.*	10.00	99.10	100.52	99.54	100.52	0.000270	0.67	14.95	15.19	0.12
Reach-1	15.*	20.00	99.10	100.75	99.75	100.77	0.000583	1.07	18.63	16.47	0.18
Reach-1	15.*	30.00	99.10	100.92	99.91	100.95	0.000880	1.40	21.49	17.41	0.22
Reach-1	15.*	40.00	99.10	101.06	100.05	101.11	0.001209	1.66	24.13	19.20	0.26
Reach-1	15.*	50.00	99.10	101.19	100.17	101.25	0.001520	1.87	26.76	21.16	0.29
Reach-1	15.*	60.00	99.10	101.31	100.28	101.38	0.001790	2.05	29.31	22.89	0.32
Reach-1	15.*	70.00	99.10	101.42	100.39	101.49	0.002015	2.20	31.88	24.50	0.34
Reach-1	15.*	80.00	99.10	101.52	100.48	101.60	0.002199	2.32	34.45	26.01	0.36
Reach-1	15.*	90.00	99.10	101.62	100.56	101.71	0.002351	2.43	37.01	27.44	0.37
Reach-1	15.*	100.00	99.10	101.71	100.65	101.81	0.002478	2.53	39.55	28.78	0.38
Reach-1	15.*	200.00	99.10	102.40	101.37	102.56	0.002493	3.22	72.93	101.35	0.40
Reach-1	15.*	500.00	99.10	103.21	102.75	103.43	0.002930	4.39	220.41	264.52	0.46
Reach-1	15.*	750.00	99.10	103.56	103.21	103.82	0.003205	4.98	328.57	337.28	0.49
Reach-1	15.*	1000.00	99.10	103.84	103.50	104.11	0.003407	5.42	427.37	392.11	0.52
Reach-1	15.*	1500.00	99.10	104.24	103.96	104.51	0.003494	5.91	587.03	399.00	0.53
Reach-1	14.8	10.00	98.77	100.52	99.20	100.52	0.000123	0.51	19.50	16.12	0.08
Reach-1	14.8	20.00	98.77	100.75	99.41	100.76	0.000298	0.86	23.34	17.25	0.13
Reach-1	14.8	30.00	98.77	100.91	99.58	100.93	0.000482	1.14	26.28	18.07	0.17
Reach-1	14.8	40.00	98.77	101.06	99.72	101.09	0.000688	1.38	28.94	19.52	0.20
Reach-1	14.8	50.00	98.77	101.18	99.85	101.22	0.000903	1.59	31.52	21.25	0.23
Reach-1	14.8	60.00	98.77	101.29	99.96	101.34	0.001107	1.77	33.99	22.78	0.25
Reach-1	14.8	70.00	98.77	101.40	100.06	101.46	0.001292	1.92	36.45	24.21	0.28
Reach-1	14.8	80.00	98.77	101.50	100.16	101.56	0.001458	2.06	38.90	25.55	0.29
Reach-1	14.8	90.00	98.77	101.59	100.25	101.66	0.001606	2.18	41.34	26.82	0.31
Reach-1	14.8	100.00	98.77	101.68	100.34	101.76	0.001738	2.29	43.74	28.02	0.32
Reach-1	14.8	200.00	98.77	102.37	101.05	102.50	0.002031	2.96	81.81	113.47	0.37
Reach-1	14.8	500.00	98.77	103.17	102.59	103.37	0.002480	4.08	237.44	275.36	0.43
Reach-1	14.8	750.00	98.77	103.52	103.08	103.75	0.002811	4.69	346.01	346.03	0.46
Reach-1	14.8	1000.00	98.77	103.79	103.38	104.04	0.003027	5.14	446.08	398.11	0.49
Reach-1	14.8	1500.00	98.77	104.18	103.86	104.44	0.003229	5.70	600.77	400.00	0.51
Reach-1	14.6*	10.00	99.06	100.51	99.51	100.52	0.000240	0.64	15.74	15.84	0.11
Reach-1	14.6*	20.00	99.06	100.73	99.71	100.75	0.000534	1.03	19.41	17.17	0.17
Reach-1	14.6*	30.00	99.06	100.89	99.87	100.92	0.000894	1.34	22.31	19.52	0.22
Reach-1	14.6*	40.00	99.06	101.03	100.01	101.07	0.001231	1.59	25.09	21.65	0.26
Reach-1	14.6*	50.00	99.06	101.15	100.13	101.20	0.001526	1.80	27.81	23.55	0.29
Reach-1	14.6*	60.00	99.06	101.25	100.23	101.31	0.001786	1.97	30.41	25.23	0.32
Reach-1	14.6*	70.00	99.06	101.35	100.33	101.42	0.002002	2.12	33.01	26.81	0.34
Reach-1	14.6*	80.00	99.06	101.45	100.43	101.53	0.002178	2.25	35.63	28.31	0.35
Reach-1	14.6*	90.00	99.06	101.54	100.51	101.63	0.002271	2.35	38.25	29.21	0.36
Reach-1	14.6*	100.00	99.06	101.62	100.59	101.72	0.002293	2.45	40.77	29.40	0.37
Reach-1	14.6*	200.00	99.06	102.31	101.31	102.46	0.002246	3.13	79.63	115.98	0.39
Reach-1	14.6*	500.00	99.06	103.11	102.63	103.32	0.002659	4.24	235.78	276.93	0.44
Reach-1	14.6*	750.00	99.06	103.46	103.07	103.69	0.002961	4.84	345.51	348.04	0.48
Reach-1	14.6*	1000.00	99.06	103.72	103.35	103.97	0.003213	5.31	442.15	397.39	0.50
Reach-1	14.6*	1500.00	99.06	104.10	103.81	104.37	0.003420	5.88	593.80	398.50	0.53
Reach-1	14.4*	10.00	99.35	100.50	99.81	100.51	0.000556	0.82	12.14	15.83	0.17
Reach-1	14.4*	20.00	99.35	100.71	100.00	100.73	0.001213	1.27	15.79	19.39	0.25
Reach-1	14.4*	30.00	99.35	100.85	100.15	100.89	0.001824	1.59	18.84	22.29	0.31
Reach-1	14.4*	40.00	99.35	100.98	100.28	101.03	0.002299	1.84	21.79	24.78	0.35

Reach-1	14.4*	50.00	99.35	101.09	100.39	101.16	0.002617	2.02	24.72	26.79	0.37
Reach-1	14.4*	60.00	99.35	101.20	100.49	101.27	0.002687	2.18	27.47	26.96	0.38
Reach-1	14.4*	70.00	99.35	101.29	100.60	101.38	0.002738	2.33	30.07	27.13	0.39
Reach-1	14.4*	80.00	99.35	101.38	100.70	101.48	0.002775	2.46	32.55	27.28	0.40
Reach-1	14.4*	90.00	99.35	101.47	100.78	101.57	0.002802	2.58	34.95	27.43	0.40
Reach-1	14.4*	100.00	99.35	101.55	100.86	101.67	0.002826	2.68	37.25	27.57	0.41
Reach-1	14.4*	200.00	99.35	102.24	101.37	102.41	0.002674	3.39	75.26	115.53	0.42
Reach-1	14.4*	500.00	99.35	103.04	102.65	103.26	0.002951	4.45	232.37	277.93	0.47
Reach-1	14.4*	750.00	99.35	103.38	103.05	103.63	0.003304	5.08	337.79	346.58	0.50
Reach-1	14.4*	1000.00	99.35	103.64	103.32	103.90	0.003475	5.50	437.12	396.28	0.52
Reach-1	14.4*	1500.00	99.35	104.02	103.75	104.29	0.003655	6.05	587.03	397.00	0.55
Reach-1	14.2*	10.00	99.65	100.47	100.10	100.49	0.001977	1.13	8.85	18.89	0.29
Reach-1	14.2*	20.00	99.65	100.66	100.27	100.69	0.003129	1.55	12.89	24.12	0.37
Reach-1	14.2*	30.00	99.65	100.79	100.41	100.84	0.003433	1.86	16.10	24.42	0.40
Reach-1	14.2*	40.00	99.65	100.90	100.53	100.97	0.003638	2.12	18.89	24.61	0.43
Reach-1	14.2*	50.00	99.65	101.01	100.63	101.09	0.003769	2.33	21.46	24.79	0.44
Reach-1	14.2*	60.00	99.65	101.10	100.69	101.20	0.003859	2.51	23.88	24.95	0.45
Reach-1	14.2*	70.00	99.65	101.20	100.76	101.31	0.003916	2.67	26.17	25.11	0.46
Reach-1	14.2*	80.00	99.65	101.28	100.82	101.41	0.003950	2.82	28.39	25.26	0.47
Reach-1	14.2*	90.00	99.65	101.37	100.87	101.50	0.003969	2.95	30.53	25.40	0.47
Reach-1	14.2*	100.00	99.65	101.45	100.93	101.60	0.003987	3.07	32.58	25.54	0.48
Reach-1	14.2*	200.00	99.65	102.13	101.40	102.35	0.003577	3.81	67.22	109.01	0.48
Reach-1	14.2*	500.00	99.65	102.96	102.66	103.20	0.003378	4.70	227.41	277.06	0.50
Reach-1	14.2*	750.00	99.65	103.29	103.02	103.55	0.003735	5.33	330.18	344.07	0.53
Reach-1	14.2*	1000.00	99.65	103.56	103.28	103.83	0.003850	5.72	429.61	394.37	0.55
Reach-1	14.2*	1500.00	99.65	103.94	103.68	104.21	0.003935	6.21	580.41	395.50	0.57
Reach-1	14	10.00	99.94	100.35	100.29	100.41	0.012534	1.87	5.34	21.45	0.66
Reach-1	14	20.00	99.94	100.50	100.40	100.58	0.010802	2.35	8.53	21.74	0.66
Reach-1	14	30.00	99.94	100.61	100.49	100.72	0.011026	2.76	10.87	21.95	0.69
Reach-1	14	40.00	99.94	100.70	100.57	100.85	0.011434	3.11	12.84	22.13	0.72
Reach-1	14	50.00	99.94	100.79	100.65	100.96	0.011082	3.36	14.89	22.31	0.72
Reach-1	14	60.00	99.94	100.88	100.72	101.07	0.010663	3.55	16.88	22.49	0.72
Reach-1	14	70.00	99.94	100.96	100.79	101.18	0.010211	3.71	18.85	22.66	0.72
Reach-1	14	80.00	99.94	101.05	100.85	101.28	0.009774	3.85	20.78	22.83	0.71
Reach-1	14	90.00	99.94	101.13	100.91	101.38	0.009377	3.97	22.67	22.99	0.70
Reach-1	14	100.00	99.94	101.21	100.97	101.47	0.009034	4.08	24.52	23.15	0.70
Reach-1	14	200.00	99.94	101.84	101.48	102.23	0.007725	5.01	43.77	65.45	0.69
Reach-1	14	500.00	99.94	102.74	102.66	103.10	0.005663	5.72	182.48	246.04	0.63
Reach-1	14	750.00	99.94	103.13	102.99	103.46	0.005073	5.97	297.11	327.15	0.61
Reach-1	14	1000.00	99.94	103.43	103.24	103.74	0.004845	6.21	401.53	386.49	0.61
Reach-1	14	1500.00	99.94	103.85	103.62	104.13	0.004424	6.44	566.55	394.00	0.59
Reach-1	13.8*	10.00	99.61	100.02	99.98	100.11	0.017565	2.36	4.23	15.51	0.80
Reach-1	13.8*	20.00	99.61	100.18	100.13	100.31	0.016492	2.88	6.96	18.10	0.82
Reach-1	13.8*	30.00	99.61	100.34	100.24	100.48	0.013898	3.02	9.93	21.12	0.78
Reach-1	13.8*	40.00	99.61	100.47	100.35	100.62	0.010856	3.09	12.96	22.08	0.71
Reach-1	13.8*	50.00	99.61	100.60	100.42	100.76	0.009164	3.18	15.73	22.45	0.67
Reach-1	13.8*	60.00	99.61	100.71	100.50	100.88	0.008314	3.30	18.21	22.78	0.65
Reach-1	13.8*	70.00	99.61	100.81	100.56	100.99	0.007705	3.40	20.57	23.09	0.64
Reach-1	13.8*	80.00	99.61	100.91	100.63	101.10	0.007246	3.50	22.85	23.38	0.62
Reach-1	13.8*	90.00	99.61	101.00	100.69	101.20	0.006890	3.59	25.05	23.66	0.62
Reach-1	13.8*	100.00	99.61	101.09	100.75	101.30	0.006621	3.68	27.16	23.93	0.61
Reach-1	13.8*	200.00	99.61	101.76	101.25	102.08	0.005871	4.54	47.68	65.44	0.61
Reach-1	13.8*	500.00	99.61	102.59	102.51	102.98	0.005558	5.74	172.51	234.22	0.63
Reach-1	13.8*	750.00	99.61	103.00	102.87	103.35	0.005042	6.04	285.01	316.93	0.62
Reach-1	13.8*	1000.00	99.61	103.30	103.13	103.64	0.004840	6.30	388.10	377.12	0.61
Reach-1	13.8*	1500.00	99.61	103.72	103.53	104.03	0.004489	6.58	554.36	395.00	0.60

Reach-1	13.6*	10.00	99.28	99.73	99.65	99.81	0.012934	2.26	4.42	13.72	0.70
Reach-1	13.6*	20.00	99.28	99.98	99.81	100.07	0.008497	2.45	8.15	16.30	0.61
Reach-1	13.6*	30.00	99.28	100.16	99.94	100.27	0.007366	2.65	11.32	18.10	0.59
Reach-1	13.6*	40.00	99.28	100.32	100.05	100.44	0.006856	2.77	14.45	20.50	0.58
Reach-1	13.6*	50.00	99.28	100.47	100.15	100.60	0.006185	2.83	17.65	22.37	0.56
Reach-1	13.6*	60.00	99.28	100.60	100.24	100.73	0.005624	2.93	20.49	22.93	0.55
Reach-1	13.6*	70.00	99.28	100.71	100.33	100.85	0.005287	3.03	23.13	23.41	0.54
Reach-1	13.6*	80.00	99.28	100.82	100.41	100.97	0.005056	3.12	25.62	23.86	0.53
Reach-1	13.6*	90.00	99.28	100.92	100.47	101.08	0.004886	3.21	28.01	24.28	0.53
Reach-1	13.6*	100.00	99.28	101.01	100.53	101.18	0.004767	3.30	30.29	24.68	0.53
Reach-1	13.6*	200.00	99.28	101.69	101.05	101.96	0.004528	4.12	52.75	70.17	0.54
Reach-1	13.6*	500.00	99.28	102.52	102.37	102.87	0.004745	5.42	179.22	237.19	0.59
Reach-1	13.6*	750.00	99.28	102.91	102.76	103.25	0.004629	5.87	286.90	316.18	0.60
Reach-1	13.6*	1000.00	99.28	103.20	103.02	103.54	0.004577	6.21	387.26	375.10	0.60
Reach-1	13.6*	1500.00	99.28	103.62	103.44	103.94	0.004350	6.56	552.90	396.00	0.60
Reach-1	13.4*	10.00	98.94	99.69	99.32	99.71	0.001954	1.25	8.01	14.61	0.30
Reach-1	13.4*	20.00	98.94	99.92	99.50	99.97	0.002584	1.70	11.74	16.50	0.36
Reach-1	13.4*	30.00	98.94	100.10	99.64	100.17	0.002981	2.03	14.81	17.84	0.39
Reach-1	13.4*	40.00	98.94	100.26	99.76	100.34	0.003306	2.26	17.71	19.57	0.42
Reach-1	13.4*	50.00	98.94	100.40	99.86	100.49	0.003545	2.41	20.70	21.80	0.44
Reach-1	13.4*	60.00	98.94	100.53	99.96	100.63	0.003543	2.54	23.58	22.94	0.44
Reach-1	13.4*	70.00	98.94	100.65	100.04	100.76	0.003518	2.66	26.30	23.73	0.45
Reach-1	13.4*	80.00	98.94	100.76	100.12	100.88	0.003491	2.77	28.88	24.34	0.45
Reach-1	13.4*	90.00	98.94	100.86	100.21	100.99	0.003474	2.87	31.37	24.91	0.45
Reach-1	13.4*	100.00	98.94	100.95	100.29	101.09	0.003470	2.96	33.75	25.45	0.45
Reach-1	13.4*	200.00	98.94	101.65	100.86	101.86	0.003560	3.76	58.72	77.91	0.48
Reach-1	13.4*	500.00	98.94	102.46	102.21	102.77	0.004003	5.07	189.89	243.75	0.54
Reach-1	13.4*	750.00	98.94	102.84	102.63	103.16	0.004090	5.60	297.01	320.90	0.56
Reach-1	13.4*	1000.00	98.94	103.12	102.90	103.45	0.004184	6.00	395.10	377.98	0.58
Reach-1	13.4*	1500.00	98.94	103.54	103.34	103.85	0.004097	6.42	558.73	397.00	0.58
Reach-1	13.2*	10.00	98.61	99.67	99.01	99.69	0.000581	0.85	11.79	15.28	0.17
Reach-1	13.2*	20.00	98.61	99.91	99.20	99.93	0.001060	1.29	15.50	16.73	0.24
Reach-1	13.2*	30.00	98.61	100.08	99.34	100.12	0.001445	1.62	18.48	17.81	0.28
Reach-1	13.2*	40.00	98.61	100.23	99.47	100.28	0.001786	1.88	21.23	19.16	0.32
Reach-1	13.2*	50.00	98.61	100.37	99.58	100.43	0.002115	2.08	24.01	21.18	0.34
Reach-1	13.2*	60.00	98.61	100.49	99.68	100.57	0.002335	2.24	26.76	22.77	0.36
Reach-1	13.2*	70.00	98.61	100.61	99.78	100.69	0.002456	2.38	29.43	23.79	0.38
Reach-1	13.2*	80.00	98.61	100.71	99.86	100.81	0.002553	2.50	32.02	24.74	0.39
Reach-1	13.2*	90.00	98.61	100.81	99.94	100.92	0.002622	2.61	34.54	25.51	0.39
Reach-1	13.2*	100.00	98.61	100.91	100.02	101.02	0.002684	2.70	36.97	26.24	0.40
Reach-1	13.2*	200.00	98.61	101.61	100.68	101.79	0.002904	3.46	65.62	88.95	0.44
Reach-1	13.2*	500.00	98.61	102.41	102.06	102.68	0.003389	4.72	203.88	252.56	0.50
Reach-1	13.2*	750.00	98.61	102.79	102.50	103.08	0.003562	5.27	312.74	328.29	0.53
Reach-1	13.2*	1000.00	98.61	103.06	102.79	103.36	0.003745	5.72	410.01	383.51	0.55
Reach-1	13.2*	1500.00	98.61	103.47	103.24	103.77	0.003773	6.19	571.55	398.00	0.56
Reach-1	13.*	10.00	98.28	99.67	98.70	99.68	0.000246	0.64	15.54	15.70	0.11
Reach-1	13.*	20.00	98.28	99.90	98.89	99.91	0.000536	1.04	19.25	16.95	0.17
Reach-1	13.*	30.00	98.28	100.07	99.05	100.10	0.000809	1.35	22.19	17.88	0.21
Reach-1	13.*	40.00	98.28	100.21	99.18	100.25	0.001078	1.61	24.85	19.11	0.25
Reach-1	13.*	50.00	98.28	100.34	99.30	100.40	0.001355	1.82	27.50	20.94	0.28
Reach-1	13.*	60.00	98.28	100.46	99.41	100.53	0.001593	1.99	30.12	22.61	0.30
Reach-1	13.*	70.00	98.28	100.58	99.51	100.65	0.001767	2.14	32.72	23.86	0.32
Reach-1	13.*	80.00	98.28	100.68	99.60	100.76	0.001911	2.27	35.27	24.98	0.34
Reach-1	13.*	90.00	98.28	100.78	99.68	100.87	0.002032	2.38	37.79	26.05	0.35
Reach-1	13.*	100.00	98.28	100.87	99.77	100.97	0.002137	2.49	40.24	27.02	0.36

Reach-1	13.*	200.00	98.28	101.57	100.47	101.73	0.002418	3.20	72.93	99.97	0.40
Reach-1	13.*	500.00	98.28	102.38	101.91	102.61	0.002912	4.40	218.57	262.58	0.46
Reach-1	13.*	750.00	98.28	102.74	102.37	103.00	0.003165	4.98	327.95	336.49	0.49
Reach-1	13.*	1000.00	98.28	103.01	102.67	103.29	0.003372	5.44	426.66	391.39	0.52
Reach-1	13.*	1500.00	98.28	103.41	103.14	103.69	0.003471	5.94	586.34	399.00	0.53
Reach-1	12.8	10.00	97.95	99.67	98.38	99.67	0.000131	0.52	19.06	15.98	0.08
Reach-1	12.8	20.00	97.95	99.89	98.59	99.91	0.000319	0.88	22.77	17.09	0.13
Reach-1	12.8	30.00	97.95	100.06	98.76	100.08	0.000515	1.17	25.67	17.91	0.17
Reach-1	12.8	40.00	97.95	100.20	98.90	100.23	0.000721	1.41	28.28	19.05	0.20
Reach-1	12.8	50.00	97.95	100.33	99.02	100.37	0.000945	1.62	30.84	20.80	0.23
Reach-1	12.8	60.00	97.95	100.45	99.14	100.50	0.001153	1.80	33.35	22.39	0.26
Reach-1	12.8	70.00	97.95	100.55	99.24	100.61	0.001340	1.95	35.86	23.87	0.28
Reach-1	12.8	80.00	97.95	100.66	99.34	100.72	0.001506	2.09	38.35	25.26	0.30
Reach-1	12.8	90.00	97.95	100.75	99.43	100.83	0.001651	2.20	40.84	26.57	0.31
Reach-1	12.8	100.00	97.95	100.84	99.52	100.93	0.001780	2.31	43.30	27.80	0.33
Reach-1	12.8	200.00	97.95	101.54	100.23	101.68	0.002069	2.98	80.76	111.59	0.37
Reach-1	12.8	500.00	97.95	102.34	101.77	102.54	0.002532	4.11	234.58	273.25	0.43
Reach-1	12.8	750.00	97.95	102.70	102.26	102.93	0.002826	4.70	345.04	345.46	0.46
Reach-1	12.8	1000.00	97.95	102.97	102.56	103.21	0.003038	5.15	445.32	397.92	0.49
Reach-1	12.8	1500.00	97.95	103.36	103.04	103.62	0.003232	5.70	600.55	400.00	0.51
Reach-1	12.6*	10.00	98.24	99.66	98.65	99.67	0.000202	0.59	16.82	16.63	0.10
Reach-1	12.6*	20.00	98.24	99.88	98.84	99.90	0.000456	0.97	20.59	17.90	0.16
Reach-1	12.6*	30.00	98.24	100.04	98.99	100.07	0.000734	1.27	23.55	19.46	0.20
Reach-1	12.6*	40.00	98.24	100.18	99.12	100.21	0.001020	1.52	26.34	21.43	0.24
Reach-1	12.6*	50.00	98.24	100.30	99.23	100.35	0.001258	1.72	29.09	23.01	0.27
Reach-1	12.6*	60.00	98.24	100.41	99.34	100.47	0.001442	1.89	31.73	24.10	0.29
Reach-1	12.6*	70.00	98.24	100.52	99.44	100.58	0.001599	2.04	34.30	25.11	0.31
Reach-1	12.6*	80.00	98.24	100.62	99.53	100.69	0.001732	2.17	36.82	26.02	0.32
Reach-1	12.6*	90.00	98.24	100.71	99.61	100.79	0.001845	2.29	39.28	26.84	0.33
Reach-1	12.6*	100.00	98.24	100.80	99.69	100.89	0.001947	2.40	41.66	27.61	0.34
Reach-1	12.6*	200.00	98.24	101.49	100.37	101.63	0.002144	3.10	80.02	115.16	0.38
Reach-1	12.6*	500.00	98.24	102.28	101.79	102.49	0.002630	4.26	233.82	274.86	0.44
Reach-1	12.6*	750.00	98.24	102.63	102.24	102.87	0.002927	4.86	343.91	346.61	0.48
Reach-1	12.6*	1000.00	98.24	102.89	102.53	103.15	0.003187	5.34	440.44	396.75	0.51
Reach-1	12.6*	1500.00	98.24	103.27	102.99	103.55	0.003409	5.92	591.80	398.50	0.53
Reach-1	12.4*	10.00	98.54	99.66	98.92	99.66	0.000381	0.71	14.11	17.57	0.14
Reach-1	12.4*	20.00	98.54	99.87	99.09	99.89	0.000799	1.11	17.98	19.82	0.21
Reach-1	12.4*	30.00	98.54	100.02	99.23	100.05	0.001208	1.42	21.17	22.10	0.26
Reach-1	12.4*	40.00	98.54	100.15	99.35	100.19	0.001482	1.66	24.09	23.13	0.29
Reach-1	12.4*	50.00	98.54	100.26	99.45	100.32	0.001687	1.86	26.86	23.87	0.31
Reach-1	12.4*	60.00	98.54	100.37	99.55	100.44	0.001854	2.04	29.46	24.49	0.33
Reach-1	12.4*	70.00	98.54	100.47	99.64	100.55	0.001993	2.19	31.96	25.06	0.34
Reach-1	12.4*	80.00	98.54	100.57	99.72	100.65	0.002111	2.33	34.35	25.60	0.35
Reach-1	12.4*	90.00	98.54	100.66	99.80	100.75	0.002213	2.45	36.67	26.11	0.36
Reach-1	12.4*	100.00	98.54	100.74	99.88	100.84	0.002308	2.57	38.88	26.58	0.37
Reach-1	12.4*	200.00	98.54	101.43	100.44	101.59	0.002429	3.31	77.06	116.24	0.41
Reach-1	12.4*	500.00	98.54	102.21	101.81	102.43	0.002875	4.46	230.52	275.22	0.47
Reach-1	12.4*	750.00	98.54	102.56	102.22	102.81	0.003195	5.08	338.01	345.45	0.50
Reach-1	12.4*	1000.00	98.54	102.81	102.49	103.08	0.003481	5.58	431.87	394.85	0.53
Reach-1	12.4*	1500.00	98.54	103.18	102.93	103.47	0.003693	6.15	580.85	397.00	0.55
Reach-1	12.2*	10.00	98.83	99.64	99.20	99.65	0.001086	0.94	10.66	19.33	0.22
Reach-1	12.2*	20.00	98.83	99.83	99.36	99.86	0.001769	1.36	14.76	22.16	0.29
Reach-1	12.2*	30.00	98.83	99.97	99.48	100.02	0.002180	1.68	17.88	22.66	0.33
Reach-1	12.2*	40.00	98.83	100.09	99.58	100.15	0.002482	1.94	20.62	23.09	0.36
Reach-1	12.2*	50.00	98.83	100.20	99.68	100.27	0.002696	2.16	23.19	23.49	0.38

Reach-1	12.2*	60.00	98.83	100.30	99.77	100.39	0.002868	2.34	25.59	23.85	0.40
Reach-1	12.2*	70.00	98.83	100.40	99.84	100.50	0.003005	2.51	27.87	24.19	0.41
Reach-1	12.2*	80.00	98.83	100.49	99.91	100.60	0.003120	2.66	30.05	24.52	0.42
Reach-1	12.2*	90.00	98.83	100.57	99.97	100.69	0.003216	2.80	32.15	24.82	0.43
Reach-1	12.2*	100.00	98.83	100.65	100.03	100.79	0.003311	2.93	34.14	25.11	0.44
Reach-1	12.2*	200.00	98.83	101.32	100.53	101.53	0.003239	3.71	69.76	112.01	0.46
Reach-1	12.2*	500.00	98.83	102.13	101.83	102.37	0.003317	4.71	226.14	275.47	0.50
Reach-1	12.2*	750.00	98.83	102.47	102.20	102.73	0.003674	5.34	329.24	342.98	0.53
Reach-1	12.2*	1000.00	98.83	102.73	102.46	103.01	0.003840	5.77	426.74	393.42	0.55
		1500.00	98.83	103.10	102.87	103.39	0.003990	6.31	574.80	395.50	0.57
Reach-1	12	10.00	99.12	99.55	99.47	99.60	0.009328	1.71	5.84	21.50	0.58
Reach-1	12	20.00	99.12	99.73	99.58	99.79	0.007498	2.10	9.54	21.83	0.56
Reach-1	12	30.00	99.12	99.84	99.67	99.94	0.007938	2.49	12.03	22.06	0.59
Reach-1	12	40.00	99.12	99.94	99.75	100.06	0.008146	2.80	14.26	22.26	0.62
Reach-1	12	50.00	99.12	100.04	99.83	100.18	0.008039	3.04	16.46	22.45	0.63
Reach-1	12	60.00	99.12	100.13	99.90	100.29	0.007964	3.24	18.50	22.63	0.63
Reach-1	12	70.00	99.12	100.21	99.97	100.40	0.007864	3.42	20.46	22.80	0.64
Reach-1	12	80.00	99.12	100.30	100.03	100.50	0.007792	3.58	22.32	22.96	0.64
Reach-1	12	90.00	99.12	100.37	100.09	100.59	0.007724	3.73	24.11	23.12	0.64
Reach-1	12	100.00	99.12	100.45	100.16	100.68	0.007703	3.88	25.79	23.26	0.65
Reach-1	12	200.00	99.12	101.05	100.66	101.42	0.007268	4.91	45.60	70.89	0.67
Reach-1	12	500.00	99.12	101.92	101.84	102.28	0.005545	5.67	184.67	247.84	0.63
Reach-1	12	750.00	99.12	102.32	102.17	102.64	0.005040	5.95	298.09	327.75	0.61
Reach-1	12	1000.00	99.12	102.61	102.42	102.92	0.004864	6.22	400.81	386.11	0.61
		1500.00	99.12	103.01	102.80	103.30	0.004548	6.51	560.97	394.00	0.60
Reach-1	11.8*	10.00	98.79	99.30	99.23	99.38	0.013807	2.26	4.43	14.51	0.72
Reach-1	11.8*	20.00	98.79	99.49	99.40	99.59	0.013931	2.58	7.74	20.80	0.75
Reach-1	11.8*	30.00	98.79	99.64	99.52	99.75	0.010350	2.65	11.34	23.41	0.67
Reach-1	11.8*	40.00	98.79	99.78	99.60	99.89	0.008446	2.78	14.41	23.64	0.63
Reach-1	11.8*	50.00	98.79	99.89	99.68	100.02	0.007590	2.92	17.10	23.84	0.61
Reach-1	11.8*	60.00	98.79	99.99	99.74	100.14	0.007189	3.08	19.48	24.01	0.60
Reach-1	11.8*	70.00	98.79	100.08	99.81	100.24	0.006870	3.22	21.75	24.18	0.60
Reach-1	11.8*	80.00	98.79	100.17	99.87	100.34	0.006673	3.35	23.87	24.33	0.60
Reach-1	11.8*	90.00	98.79	100.25	99.93	100.44	0.006517	3.48	25.89	24.48	0.60
Reach-1	11.8*	100.00	98.79	100.33	99.98	100.53	0.006451	3.60	27.76	24.61	0.60
Reach-1	11.8*	200.00	98.79	100.95	100.47	101.27	0.006015	4.56	48.10	68.71	0.61
Reach-1	11.8*	500.00	98.79	101.80	101.70	102.16	0.005387	5.63	178.32	239.76	0.62
Reach-1	11.8*	750.00	98.79	102.20	102.06	102.54	0.004984	5.96	289.45	320.18	0.61
Reach-1	11.8*	1000.00	98.79	102.48	102.30	102.82	0.004862	6.26	390.04	378.52	0.61
		1500.00	98.79	102.90	102.71	103.21	0.004542	6.56	554.00	395.00	0.60
Reach-1	11.6*	10.00	98.46	98.96	98.91	99.07	0.017126	2.62	3.82	11.74	0.81
Reach-1	11.6*	20.00	98.46	99.22	99.09	99.34	0.011202	2.79	7.17	14.45	0.70
Reach-1	11.6*	30.00	98.46	99.41	99.23	99.55	0.010201	2.92	10.26	17.95	0.68
Reach-1	11.6*	40.00	98.46	99.59	99.36	99.72	0.008913	2.89	13.83	22.22	0.65
Reach-1	11.6*	50.00	98.46	99.74	99.48	99.87	0.007671	2.88	17.39	25.14	0.61
Reach-1	11.6*	60.00	98.46	99.86	99.57	99.99	0.006537	2.93	20.45	25.34	0.58
Reach-1	11.6*	70.00	98.46	99.97	99.66	100.11	0.005933	3.02	23.20	25.52	0.56
Reach-1	11.6*	80.00	98.46	100.06	99.73	100.21	0.005628	3.12	25.63	25.68	0.55
Reach-1	11.6*	90.00	98.46	100.15	99.78	100.31	0.005417	3.22	27.93	25.83	0.55
Reach-1	11.6*	100.00	98.46	100.23	99.84	100.40	0.005333	3.34	29.98	25.96	0.55
Reach-1	11.6*	200.00	98.46	100.88	100.30	101.15	0.004922	4.21	51.88	70.92	0.56
Reach-1	11.6*	500.00	98.46	101.72	101.57	102.06	0.004767	5.37	183.02	241.37	0.59
Reach-1	11.6*	750.00	98.46	102.10	101.94	102.44	0.004647	5.81	290.87	319.43	0.59
Reach-1	11.6*	1000.00	98.46	102.38	102.20	102.72	0.004664	6.18	388.33	376.29	0.60
		1500.00	98.46	102.80	102.62	103.11	0.004430	6.53	552.49	396.00	0.60

Reach-1	11.4*	10.00	98.13	98.89	98.58	98.93	0.002989	1.49	6.72	12.85	0.36
Reach-1	11.4*	20.00	98.13	99.14	98.77	99.20	0.003686	1.97	10.16	14.84	0.42
Reach-1	11.4*	30.00	98.13	99.32	98.93	99.40	0.004254	2.32	12.95	16.47	0.46
Reach-1	11.4*	40.00	98.13	99.49	99.05	99.58	0.004795	2.52	15.89	19.53	0.49
Reach-1	11.4*	50.00	98.13	99.63	99.16	99.74	0.005005	2.64	18.95	22.43	0.51
Reach-1	11.4*	60.00	98.13	99.76	99.26	99.87	0.005074	2.73	21.98	24.96	0.51
Reach-1	11.4*	70.00	98.13	99.87	99.37	100.00	0.004953	2.80	24.99	26.82	0.51
Reach-1	11.4*	80.00	98.13	99.98	99.47	100.11	0.004601	2.88	27.79	27.00	0.50
Reach-1	11.4*	90.00	98.13	100.07	99.56	100.21	0.004388	2.96	30.37	27.16	0.49
Reach-1	11.4*	100.00	98.13	100.16	99.64	100.30	0.004316	3.07	32.61	27.30	0.49
Reach-1	11.4*	200.00	98.13	100.82	100.15	101.05	0.003972	3.87	57.36	78.40	0.50
Reach-1	11.4*	500.00	98.13	101.66	101.42	101.96	0.004022	5.01	194.70	248.07	0.54
Reach-1	11.4*	750.00	98.13	102.04	101.82	102.34	0.004100	5.53	301.96	323.73	0.56
Reach-1	11.4*	1000.00	98.13	102.31	102.08	102.63	0.004245	5.95	397.50	378.59	0.58
Reach-1	11.4*	1500.00	98.13	102.72	102.51	103.03	0.004172	6.38	559.00	397.00	0.58
Reach-1	11.2*	10.00	97.79	98.88	98.24	98.90	0.000732	0.93	10.72	14.17	0.19
Reach-1	11.2*	20.00	97.79	99.12	98.44	99.15	0.001294	1.40	14.30	15.69	0.26
Reach-1	11.2*	30.00	97.79	99.29	98.60	99.34	0.001763	1.75	17.09	16.78	0.31
Reach-1	11.2*	40.00	97.79	99.45	98.73	99.51	0.002288	2.02	19.80	19.17	0.35
Reach-1	11.2*	50.00	97.79	99.58	98.85	99.66	0.002684	2.22	22.57	21.47	0.38
Reach-1	11.2*	60.00	97.79	99.70	98.95	99.79	0.002987	2.37	25.27	23.49	0.40
Reach-1	11.2*	70.00	97.79	99.81	99.05	99.91	0.003200	2.50	27.99	25.37	0.42
Reach-1	11.2*	80.00	97.79	99.92	99.14	100.02	0.003350	2.60	30.72	27.12	0.43
Reach-1	11.2*	90.00	97.79	100.01	99.23	100.13	0.003411	2.69	33.40	28.40	0.44
Reach-1	11.2*	100.00	97.79	100.10	99.31	100.22	0.003378	2.79	35.80	28.56	0.44
Reach-1	11.2*	200.00	97.79	100.78	99.99	100.97	0.003179	3.54	63.76	86.97	0.45
Reach-1	11.2*	500.00	97.79	101.61	101.26	101.87	0.003432	4.70	206.32	255.29	0.50
Reach-1	11.2*	750.00	97.79	101.98	101.70	102.26	0.003600	5.24	315.22	330.42	0.52
Reach-1	11.2*	1000.00	97.79	102.24	101.97	102.54	0.003833	5.71	409.61	383.82	0.55
Reach-1	11.2*	1500.00	97.79	102.65	102.42	102.94	0.003883	6.19	568.54	398.00	0.56
Reach-1	11.*	10.00	97.46	98.88	97.90	98.89	0.000270	0.67	14.97	15.20	0.12
Reach-1	11.*	20.00	97.46	99.11	98.11	99.13	0.000577	1.07	18.70	16.50	0.18
Reach-1	11.*	30.00	97.46	99.28	98.27	99.31	0.000872	1.39	21.55	17.43	0.22
Reach-1	11.*	40.00	97.46	99.43	98.41	99.47	0.001202	1.65	24.20	19.25	0.26
Reach-1	11.*	50.00	97.46	99.56	98.53	99.61	0.001511	1.86	26.83	21.21	0.29
Reach-1	11.*	60.00	97.46	99.67	98.64	99.74	0.001785	2.04	29.35	22.91	0.32
Reach-1	11.*	70.00	97.46	99.78	98.75	99.85	0.002015	2.20	31.87	24.50	0.34
Reach-1	11.*	80.00	97.46	99.88	98.84	99.96	0.002208	2.33	34.38	25.98	0.36
Reach-1	11.*	90.00	97.46	99.97	98.92	100.06	0.002373	2.44	36.86	27.36	0.37
Reach-1	11.*	100.00	97.46	100.05	99.01	100.15	0.002536	2.55	39.16	28.59	0.38
Reach-1	11.*	200.00	97.46	100.74	99.73	100.90	0.002590	3.26	71.06	97.54	0.41
Reach-1	11.*	500.00	97.46	101.57	101.11	101.79	0.002913	4.38	221.17	265.10	0.46
Reach-1	11.*	750.00	97.46	101.93	101.57	102.18	0.003176	4.96	330.13	338.21	0.49
Reach-1	11.*	1000.00	97.46	102.19	101.86	102.46	0.003442	5.44	425.23	391.01	0.52
Reach-1	11.*	1500.00	97.46	102.58	102.32	102.86	0.003578	5.97	581.82	399.00	0.54
Reach-1	10.8	10.00	97.13	98.88	97.56	98.88	0.000123	0.51	19.52	16.12	0.08
Reach-1	10.8	20.00	97.13	99.11	97.77	99.12	0.000296	0.85	23.41	17.27	0.13
Reach-1	10.8	30.00	97.13	99.28	97.94	99.30	0.000479	1.14	26.35	18.09	0.17
Reach-1	10.8	40.00	97.13	99.42	98.08	99.45	0.000685	1.38	29.01	19.57	0.20
Reach-1	10.8	50.00	97.13	99.55	98.21	99.58	0.000899	1.58	31.59	21.29	0.23
Reach-1	10.8	60.00	97.13	99.66	98.32	99.70	0.001104	1.76	34.03	22.80	0.25
Reach-1	10.8	70.00	97.13	99.76	98.42	99.82	0.001292	1.92	36.45	24.21	0.28
Reach-1	10.8	80.00	97.13	99.86	98.52	99.92	0.001463	2.06	38.84	25.52	0.29
Reach-1	10.8	90.00	97.13	99.94	98.61	100.02	0.001619	2.19	41.19	26.75	0.31
Reach-1	10.8	100.00	97.13	100.02	98.70	100.11	0.001775	2.31	43.35	27.82	0.33
Reach-1	10.8	200.00	97.13	100.71	99.41	100.85	0.002116	3.00	79.53	109.35	0.37

Reach-1	10.8	500.00	97.13	101.54	100.95	101.73	0.002464	4.07	238.31	275.99	0.43
Reach-1	10.8	750.00	97.13	101.89	101.44	102.11	0.002783	4.67	347.84	347.09	0.46
Reach-1	10.8	1000.00	97.13	102.14	101.74	102.39	0.003065	5.16	443.56	397.48	0.49
Reach-1	10.8	1500.00	97.13	102.53	102.22	102.79	0.003286	5.74	596.79	400.00	0.52
Reach-1	10.6*	10.00	97.42	98.87	97.87	98.88	0.000239	0.63	15.76	15.85	0.11
Reach-1	10.6*	20.00	97.42	99.10	98.07	99.11	0.000528	1.03	19.49	17.19	0.17
Reach-1	10.6*	30.00	97.42	99.26	98.23	99.28	0.000887	1.34	22.39	19.58	0.22
Reach-1	10.6*	40.00	97.42	99.39	98.37	99.43	0.001223	1.59	25.17	21.71	0.26
Reach-1	10.6*	50.00	97.42	99.51	98.49	99.56	0.001515	1.79	27.89	23.61	0.29
Reach-1	10.6*	60.00	97.42	99.62	98.59	99.68	0.001779	1.97	30.46	25.26	0.32
Reach-1	10.6*	70.00	97.42	99.71	98.69	99.78	0.002002	2.12	33.01	26.81	0.34
Reach-1	10.6*	80.00	97.42	99.81	98.79	99.88	0.002189	2.25	35.55	28.27	0.35
Reach-1	10.6*	90.00	97.42	99.89	98.87	99.98	0.002305	2.36	38.07	29.20	0.36
Reach-1	10.6*	100.00	97.42	99.97	98.95	100.06	0.002378	2.48	40.30	29.37	0.37
Reach-1	10.6*	200.00	97.42	100.65	99.67	100.80	0.002358	3.19	76.91	111.13	0.39
Reach-1	10.6*	500.00	97.42	101.47	100.99	101.68	0.002639	4.23	236.83	277.70	0.44
Reach-1	10.6*	750.00	97.42	101.83	101.43	102.06	0.002932	4.82	347.27	349.06	0.48
Reach-1	10.6*	1000.00	97.42	102.07	101.71	102.33	0.003272	5.35	438.54	396.48	0.51
Reach-1	10.6*	1500.00	97.42	102.44	102.17	102.72	0.003511	5.94	587.98	398.50	0.54
Reach-1	10.4*	10.00	97.71	98.86	98.17	98.87	0.000554	0.82	12.15	15.83	0.17
Reach-1	10.4*	20.00	97.71	99.07	98.36	99.10	0.001197	1.26	15.88	19.48	0.25
Reach-1	10.4*	30.00	97.71	99.22	98.51	99.26	0.001802	1.58	18.94	22.38	0.30
Reach-1	10.4*	40.00	97.71	99.34	98.64	99.40	0.002272	1.83	21.89	24.86	0.34
Reach-1	10.4*	50.00	97.71	99.46	98.75	99.52	0.002579	2.01	24.83	26.80	0.37
Reach-1	10.4*	60.00	97.71	99.56	98.85	99.63	0.002667	2.18	27.53	26.97	0.38
Reach-1	10.4*	70.00	97.71	99.65	98.96	99.74	0.002738	2.33	30.07	27.13	0.39
Reach-1	10.4*	80.00	97.71	99.74	99.06	99.83	0.002800	2.46	32.46	27.27	0.40
Reach-1	10.4*	90.00	97.71	99.82	99.14	99.93	0.002856	2.59	34.74	27.42	0.41
Reach-1	10.4*	100.00	97.71	99.89	99.22	100.01	0.002956	2.72	36.72	27.54	0.42
Reach-1	10.4*	200.00	97.71	100.57	99.73	100.75	0.002848	3.47	71.90	109.47	0.43
Reach-1	10.4*	500.00	97.71	101.40	101.01	101.62	0.002921	4.43	233.74	278.92	0.47
Reach-1	10.4*	750.00	97.71	101.75	101.41	101.99	0.003222	5.03	342.15	349.13	0.50
Reach-1	10.4*	1000.00	97.71	101.99	101.68	102.26	0.003579	5.56	431.45	394.84	0.53
Reach-1	10.4*	1500.00	97.71	102.36	102.11	102.64	0.003811	6.15	578.04	397.00	0.56
Reach-1	10.2*	10.00	98.01	98.83	98.46	98.85	0.001966	1.13	8.87	18.92	0.29
Reach-1	10.2*	20.00	98.01	99.02	98.63	99.06	0.003024	1.53	13.04	24.20	0.37
Reach-1	10.2*	30.00	98.01	99.16	98.77	99.21	0.003332	1.85	16.24	24.43	0.40
Reach-1	10.2*	40.00	98.01	99.27	98.89	99.34	0.003549	2.10	19.04	24.62	0.42
Reach-1	10.2*	50.00	98.01	99.37	98.99	99.46	0.003686	2.31	21.62	24.80	0.44
Reach-1	10.2*	60.00	98.01	99.47	99.05	99.57	0.003817	2.50	23.96	24.96	0.45
Reach-1	10.2*	70.00	98.01	99.56	99.12	99.67	0.003917	2.67	26.17	25.11	0.46
Reach-1	10.2*	80.00	98.01	99.64	99.18	99.76	0.004002	2.83	28.27	25.25	0.47
Reach-1	10.2*	90.00	98.01	99.72	99.23	99.86	0.004079	2.97	30.27	25.38	0.48
Reach-1	10.2*	100.00	98.01	99.78	99.29	99.94	0.004255	3.13	31.92	25.50	0.49
Reach-1	10.2*	200.00	98.01	100.45	99.76	100.68	0.003946	3.94	62.58	100.02	0.51
Reach-1	10.2*	500.00	98.01	101.33	101.02	101.56	0.003319	4.66	229.59	278.65	0.49
Reach-1	10.2*	750.00	98.01	101.66	101.38	101.92	0.003665	5.29	333.33	345.92	0.53
Reach-1	10.2*	1000.00	98.01	101.89	101.64	102.18	0.004077	5.85	418.98	391.67	0.56
Reach-1	10.2*	1500.00	98.01	102.26	102.04	102.56	0.004220	6.39	565.78	395.50	0.58
Reach-1	10	10.00	98.30	98.65	98.65	98.74	0.029589	2.46	4.07	20.83	0.98
Reach-1	10	20.00	98.30	98.76	98.76	98.91	0.027738	3.13	6.39	21.55	1.01
Reach-1	10	30.00	98.30	98.85	98.85	99.05	0.025448	3.57	8.41	21.73	1.01
Reach-1	10	40.00	98.30	98.94	98.93	99.17	0.023349	3.88	10.30	21.90	1.00
Reach-1	10	50.00	98.30	99.01	99.01	99.29	0.022955	4.21	11.88	22.05	1.01
Reach-1	10	60.00	98.30	99.08	99.08	99.39	0.021965	4.45	13.49	22.19	1.01

Reach-1	10	70.00	98.30	99.15	99.15	99.49	0.021433	4.68	14.95	22.32	1.01
Reach-1	10	80.00	98.30	99.21	99.21	99.58	0.020932	4.89	16.37	22.44	1.01
Reach-1	10	90.00	98.30	99.28	99.28	99.67	0.020363	5.06	17.77	22.57	1.01
Reach-1	10	100.00	98.30	99.39	99.33	99.76	0.016300	4.91	20.36	22.79	0.92
Reach-1	10	200.00	98.30	100.03	99.84	100.53	0.011446	5.66	35.44	30.08	0.82
Reach-1	10	500.00	98.30	101.02	101.02	101.45	0.006713	6.11	165.60	231.71	0.69
Reach-1	10	750.00	98.30	101.35	101.35	101.80	0.006973	6.77	252.70	298.35	0.71
Reach-1	10	1000.00	98.30	101.69	101.60	102.07	0.005930	6.73	364.77	366.69	0.67
Reach-1	10	1500.00	98.30	102.13	101.98	102.45	0.005155	6.85	536.22	394.00	0.64

Design Channel: Bankfull Discharge = 200 cfs; Slope = 0.0016 ft/ft

Profile Output Table - Standard Table 1
HEC-RAS Plan: q200sp16 River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 654
Plans = 1
Profiles = 15

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	20	10.00	99.00	99.52	99.45	99.59	0.013683	2.03	4.92	18.78	0.70
Reach-1	20	20.00	99.00	99.73	99.60	99.80	0.009002	2.14	9.33	23.97	0.61
Reach-1	20	30.00	99.00	99.90	99.70	99.97	0.006350	2.19	13.72	26.32	0.53
Reach-1	20	40.00	99.00	100.05	99.79	100.13	0.005083	2.25	17.82	27.72	0.49
Reach-1	20	50.00	99.00	100.19	99.86	100.27	0.004312	2.29	21.85	29.15	0.47
Reach-1	20	60.00	99.00	100.32	99.92	100.41	0.003732	2.33	25.71	29.78	0.44
Reach-1	20	70.00	99.00	100.45	99.98	100.53	0.003303	2.38	29.38	30.00	0.42
Reach-1	20	80.00	99.00	100.56	100.04	100.65	0.003033	2.44	32.78	30.19	0.41
Reach-1	20	90.00	99.00	100.67	100.10	100.76	0.002829	2.50	36.06	30.38	0.40
Reach-1	20	100.00	99.00	100.77	100.15	100.87	0.002687	2.55	39.15	30.56	0.40
Reach-1	20	200.00	99.00	101.60	100.58	101.74	0.002175	3.08	64.99	31.99	0.38
Reach-1	20	500.00	99.00	102.75	101.53	102.94	0.001938	3.92	235.58	264.86	0.39
Reach-1	20	750.00	99.00	103.24	102.53	103.43	0.001839	4.20	391.55	365.24	0.39
Reach-1	20	1000.00	99.00	103.59	102.91	103.77	0.001765	4.37	527.99	402.00	0.38
Reach-1	20	1500.00	99.00	104.10	103.47	104.27	0.001718	4.67	733.75	402.00	0.39
Reach-1	19.8*	10.00	98.73	99.37	99.19	99.41	0.006132	1.65	6.06	17.27	0.49
Reach-1	19.8*	20.00	98.73	99.61	99.36	99.67	0.004665	1.85	10.81	21.13	0.46
Reach-1	19.8*	30.00	98.73	99.81	99.48	99.87	0.004080	1.96	15.34	24.86	0.44
Reach-1	19.8*	40.00	98.73	99.98	99.58	100.04	0.003464	2.03	19.67	26.52	0.42
Reach-1	19.8*	50.00	98.73	100.13	99.66	100.20	0.003089	2.10	23.81	28.02	0.40
Reach-1	19.8*	60.00	98.73	100.27	99.75	100.34	0.002848	2.16	27.75	29.37	0.39
Reach-1	19.8*	70.00	98.73	100.40	99.82	100.47	0.002676	2.21	31.61	30.77	0.39
Reach-1	19.8*	80.00	98.73	100.51	99.88	100.59	0.002478	2.27	35.29	31.20	0.38
Reach-1	19.8*	90.00	98.73	100.63	99.94	100.71	0.002314	2.32	38.80	31.39	0.37
Reach-1	19.8*	100.00	98.73	100.73	99.99	100.82	0.002204	2.38	42.08	31.57	0.36
Reach-1	19.8*	200.00	98.73	101.57	100.47	101.70	0.001843	2.89	69.11	33.00	0.35
Reach-1	19.8*	500.00	98.73	102.72	101.39	102.90	0.001747	3.77	241.00	265.90	0.37
Reach-1	19.8*	750.00	98.73	103.21	102.41	103.39	0.001704	4.09	396.46	365.64	0.37
Reach-1	19.8*	1000.00	98.73	103.56	102.82	103.73	0.001667	4.30	531.98	402.66	0.37
Reach-1	19.8*	1500.00	98.73	104.07	103.31	104.24	0.001648	4.62	737.80	402.66	0.38
Reach-1	19.6*	10.00	98.47	99.34	98.92	99.35	0.001208	0.99	10.08	18.12	0.23
Reach-1	19.6*	20.00	98.47	99.58	99.08	99.61	0.001606	1.36	14.68	20.21	0.28
Reach-1	19.6*	30.00	98.47	99.77	99.20	99.81	0.001798	1.60	18.73	21.96	0.31
Reach-1	19.6*	40.00	98.47	99.94	99.31	99.99	0.002022	1.77	22.60	24.87	0.33
Reach-1	19.6*	50.00	98.47	100.09	99.40	100.14	0.002044	1.88	26.56	26.83	0.33
Reach-1	19.6*	60.00	98.47	100.23	99.49	100.29	0.002022	1.98	30.38	28.28	0.34
Reach-1	19.6*	70.00	98.47	100.36	99.57	100.42	0.001992	2.05	34.13	29.64	0.34
Reach-1	19.6*	80.00	98.47	100.48	99.64	100.55	0.001969	2.12	37.75	30.92	0.34

Reach-1	19.6*	90.00	98.47	100.59	99.71	100.66	0.001947	2.18	41.34	32.24	0.34
Reach-1	19.6*	100.00	98.47	100.70	99.78	100.77	0.001868	2.23	44.79	32.51	0.34
Reach-1	19.6*	200.00	98.47	101.54	100.32	101.66	0.001604	2.74	72.94	36.60	0.33
Reach-1	19.6*	500.00	98.47	102.70	101.27	102.86	0.001572	3.62	249.84	270.10	0.35
Reach-1	19.6*	750.00	98.47	103.19	102.28	103.36	0.001566	3.96	406.52	369.30	0.36
Reach-1	19.6*	1000.00	98.47	103.53	102.74	103.69	0.001551	4.17	541.92	403.34	0.36
Reach-1	19.6*	1500.00	98.47	104.04	103.24	104.20	0.001561	4.53	747.35	403.34	0.37
Reach-1	19.4*	10.00	98.20	99.33	98.64	99.34	0.000361	0.68	14.68	18.54	0.13
Reach-1	19.4*	20.00	98.20	99.57	98.80	99.58	0.000658	1.04	19.22	20.10	0.19
Reach-1	19.4*	30.00	98.20	99.76	98.92	99.78	0.000875	1.30	23.15	21.47	0.22
Reach-1	19.4*	40.00	98.20	99.92	99.03	99.95	0.001039	1.50	26.72	22.65	0.24
Reach-1	19.4*	50.00	98.20	100.07	99.13	100.11	0.001223	1.65	30.25	24.99	0.26
Reach-1	19.4*	60.00	98.20	100.20	99.21	100.25	0.001352	1.77	33.81	27.05	0.28
Reach-1	19.4*	70.00	98.20	100.33	99.30	100.39	0.001413	1.87	37.37	28.46	0.29
Reach-1	19.4*	80.00	98.20	100.45	99.37	100.51	0.001460	1.96	40.83	29.77	0.29
Reach-1	19.4*	90.00	98.20	100.56	99.45	100.63	0.001492	2.03	44.27	31.02	0.30
Reach-1	19.4*	100.00	98.20	100.67	99.52	100.74	0.001519	2.10	47.62	32.23	0.30
Reach-1	19.4*	200.00	98.20	101.52	100.13	101.63	0.001418	2.61	76.70	39.17	0.31
Reach-1	19.4*	500.00	98.20	102.67	101.15	102.83	0.001442	3.49	256.30	272.35	0.34
Reach-1	19.4*	750.00	98.20	103.16	102.13	103.32	0.001465	3.85	413.16	370.97	0.35
Reach-1	19.4*	1000.00	98.20	103.50	102.65	103.66	0.001471	4.08	547.88	404.00	0.35
Reach-1	19.4*	1500.00	98.20	104.01	103.18	104.17	0.001502	4.45	753.00	404.00	0.36
Reach-1	19.2*	10.00	97.93	99.33	98.35	99.33	0.000152	0.52	19.29	18.89	0.09
Reach-1	19.2*	20.00	97.93	99.56	98.50	99.57	0.000329	0.84	23.83	20.18	0.14
Reach-1	19.2*	30.00	97.93	99.75	98.63	99.77	0.000484	1.08	27.70	21.31	0.17
Reach-1	19.2*	40.00	97.93	99.91	98.74	99.93	0.000618	1.28	31.18	22.29	0.19
Reach-1	19.2*	50.00	97.93	100.06	98.85	100.09	0.000728	1.45	34.52	23.20	0.21
Reach-1	19.2*	60.00	97.93	100.19	98.93	100.23	0.000859	1.59	37.71	24.93	0.23
Reach-1	19.2*	70.00	97.93	100.31	99.02	100.36	0.000979	1.71	40.97	26.86	0.24
Reach-1	19.2*	80.00	97.93	100.43	99.10	100.48	0.001067	1.81	44.20	28.36	0.26
Reach-1	19.2*	90.00	97.93	100.54	99.18	100.60	0.001134	1.90	47.45	29.68	0.26
Reach-1	19.2*	100.00	97.93	100.65	99.25	100.71	0.001191	1.98	50.63	30.92	0.27
Reach-1	19.2*	200.00	97.93	101.50	99.86	101.60	0.001288	2.50	80.04	42.02	0.30
Reach-1	19.2*	500.00	97.93	102.65	101.07	102.80	0.001340	3.37	263.13	275.59	0.32
Reach-1	19.2*	750.00	97.93	103.14	101.98	103.29	0.001380	3.74	420.91	374.00	0.34
Reach-1	19.2*	1000.00	97.93	103.48	102.57	103.63	0.001398	3.98	555.38	404.66	0.34
Reach-1	19.2*	1500.00	97.93	103.98	103.11	104.14	0.001446	4.37	760.02	404.66	0.36
Reach-1	19.*	10.00	97.67	99.33	98.06	99.33	0.000078	0.42	23.81	19.21	0.07
Reach-1	19.*	20.00	97.67	99.56	98.22	99.57	0.000189	0.70	28.38	20.33	0.11
Reach-1	19.*	30.00	97.67	99.75	98.35	99.76	0.000298	0.93	32.23	21.28	0.13
Reach-1	19.*	40.00	97.67	99.90	98.47	99.92	0.000399	1.12	35.66	22.12	0.16
Reach-1	19.*	50.00	97.67	100.05	98.57	100.07	0.000489	1.28	38.93	22.90	0.17
Reach-1	19.*	60.00	97.67	100.18	98.67	100.21	0.000570	1.43	41.99	23.60	0.19
Reach-1	19.*	70.00	97.67	100.30	98.75	100.34	0.000659	1.56	44.97	24.76	0.20
Reach-1	19.*	80.00	97.67	100.42	98.84	100.46	0.000759	1.67	47.91	26.43	0.22
Reach-1	19.*	90.00	97.67	100.53	98.91	100.58	0.000847	1.77	50.91	28.03	0.23
Reach-1	19.*	100.00	97.67	100.63	98.99	100.69	0.000920	1.86	53.88	29.35	0.24
Reach-1	19.*	200.00	97.67	101.48	99.62	101.57	0.001198	2.42	83.04	47.01	0.28
Reach-1	19.*	500.00	97.67	102.63	100.94	102.77	0.001251	3.26	271.79	280.02	0.31
Reach-1	19.*	750.00	97.67	103.12	101.81	103.26	0.001300	3.63	431.11	377.80	0.32
Reach-1	19.*	1000.00	97.67	103.45	102.48	103.60	0.001326	3.87	565.46	405.34	0.33
Reach-1	19.*	1500.00	97.67	103.96	103.04	104.11	0.001389	4.27	769.48	405.34	0.35
Reach-1	18.8	10.00	97.40	99.33	97.78	99.33	0.000045	0.35	28.42	19.49	0.05
Reach-1	18.8	20.00	97.40	99.56	97.94	99.56	0.000118	0.61	33.02	20.49	0.08
Reach-1	18.8	30.00	97.40	99.74	98.07	99.75	0.000195	0.81	36.87	21.31	0.11

Reach-1	18.8	40.00	97.40	99.90	98.18	99.92	0.000271	0.99	40.28	22.07	0.13
Reach-1	18.8	50.00	97.40	100.04	98.29	100.06	0.000342	1.15	43.51	22.76	0.15
Reach-1	18.8	60.00	97.40	100.17	98.39	100.20	0.000409	1.29	46.53	23.39	0.16
Reach-1	18.8	70.00	97.40	100.30	98.47	100.33	0.000471	1.42	49.44	23.98	0.17
Reach-1	18.8	80.00	97.40	100.41	98.56	100.45	0.000533	1.53	52.19	24.63	0.19
Reach-1	18.8	90.00	97.40	100.52	98.64	100.56	0.000612	1.64	54.94	26.09	0.20
Reach-1	18.8	100.00	97.40	100.62	98.71	100.67	0.000687	1.73	57.67	27.47	0.21
Reach-1	18.8	200.00	97.40	101.46	99.35	101.55	0.001130	2.34	85.81	50.19	0.28
Reach-1	18.8	500.00	97.40	102.61	100.73	102.74	0.001186	3.16	278.57	283.69	0.30
Reach-1	18.8	750.00	97.40	103.10	101.65	103.24	0.001242	3.53	439.21	381.38	0.32
Reach-1	18.8	1000.00	97.40	103.43	102.41	103.57	0.001273	3.78	573.49	406.00	0.32
Reach-1	18.8	1500.00	97.40	103.93	102.98	104.08	0.001347	4.19	776.93	406.00	0.34
Reach-1	18.6*	10.00	97.72	99.33	98.13	99.33	0.000089	0.43	23.01	19.46	0.07
Reach-1	18.6*	20.00	97.72	99.55	98.28	99.56	0.000211	0.73	27.56	20.64	0.11
Reach-1	18.6*	30.00	97.72	99.73	98.41	99.75	0.000330	0.96	31.38	21.67	0.14
Reach-1	18.6*	40.00	97.72	99.89	98.53	99.91	0.000441	1.15	34.78	22.54	0.16
Reach-1	18.6*	50.00	97.72	100.03	98.63	100.06	0.000538	1.31	38.02	23.35	0.18
Reach-1	18.6*	60.00	97.72	100.16	98.72	100.19	0.000644	1.46	41.08	24.67	0.20
Reach-1	18.6*	70.00	97.72	100.28	98.81	100.32	0.000755	1.58	44.16	26.45	0.22
Reach-1	18.6*	80.00	97.72	100.39	98.89	100.43	0.000852	1.69	47.21	28.04	0.23
Reach-1	18.6*	90.00	97.72	100.50	98.97	100.55	0.000929	1.79	50.28	29.36	0.24
Reach-1	18.6*	100.00	97.72	100.60	99.04	100.65	0.000998	1.88	53.29	30.60	0.25
Reach-1	18.6*	200.00	97.72	101.43	99.65	101.52	0.001204	2.44	82.46	48.50	0.29
Reach-1	18.6*	500.00	97.72	102.58	100.94	102.72	0.001257	3.28	272.44	281.59	0.31
Reach-1	18.6*	750.00	97.72	103.06	101.81	103.21	0.001308	3.65	431.79	379.24	0.33
Reach-1	18.6*	1000.00	97.72	103.40	102.45	103.54	0.001331	3.89	565.84	405.00	0.33
Reach-1	18.6*	1500.00	97.72	103.90	103.00	104.05	0.001398	4.30	768.61	405.00	0.35
Reach-1	18.4*	10.00	98.04	99.32	98.48	99.33	0.000216	0.57	17.51	19.52	0.11
Reach-1	18.4*	20.00	98.04	99.54	98.64	99.55	0.000450	0.91	21.98	21.08	0.16
Reach-1	18.4*	30.00	98.04	99.72	98.76	99.74	0.000646	1.16	25.79	22.35	0.19
Reach-1	18.4*	40.00	98.04	99.87	98.87	99.90	0.000844	1.37	29.24	24.28	0.22
Reach-1	18.4*	50.00	98.04	100.00	98.97	100.04	0.001022	1.53	32.75	26.62	0.24
Reach-1	18.4*	60.00	98.04	100.13	99.05	100.17	0.001131	1.66	36.18	28.00	0.26
Reach-1	18.4*	70.00	98.04	100.25	99.14	100.30	0.001214	1.77	39.57	29.31	0.27
Reach-1	18.4*	80.00	98.04	100.36	99.21	100.41	0.001283	1.87	42.87	30.52	0.28
Reach-1	18.4*	90.00	98.04	100.46	99.29	100.52	0.001336	1.95	46.15	31.68	0.28
Reach-1	18.4*	100.00	98.04	100.56	99.36	100.63	0.001385	2.03	49.37	32.88	0.29
Reach-1	18.4*	200.00	98.04	101.39	99.97	101.49	0.001351	2.57	78.04	45.60	0.30
Reach-1	18.4*	500.00	98.04	102.54	100.99	102.69	0.001378	3.43	264.07	278.43	0.33
Reach-1	18.4*	750.00	98.04	103.02	101.97	103.18	0.001412	3.79	422.18	376.35	0.34
Reach-1	18.4*	1000.00	98.04	103.36	102.49	103.52	0.001420	4.02	556.42	404.00	0.35
Reach-1	18.4*	1500.00	98.04	103.86	103.02	104.02	0.001471	4.42	759.00	404.00	0.36
Reach-1	18.2*	10.00	98.36	99.31	98.82	99.32	0.000828	0.85	11.74	20.03	0.20
Reach-1	18.2*	20.00	98.36	99.52	98.98	99.54	0.001354	1.24	16.16	22.67	0.26
Reach-1	18.2*	30.00	98.36	99.68	99.10	99.72	0.001700	1.48	20.23	25.61	0.29
Reach-1	18.2*	40.00	98.36	99.83	99.21	99.87	0.001838	1.66	24.02	27.06	0.31
Reach-1	18.2*	50.00	98.36	99.96	99.29	100.01	0.001899	1.80	27.75	28.41	0.32
Reach-1	18.2*	60.00	98.36	100.08	99.38	100.14	0.001933	1.91	31.34	29.66	0.33
Reach-1	18.2*	70.00	98.36	100.20	99.45	100.26	0.001947	2.01	34.91	30.93	0.33
Reach-1	18.2*	80.00	98.36	100.31	99.53	100.38	0.001928	2.09	38.36	31.77	0.33
Reach-1	18.2*	90.00	98.36	100.42	99.60	100.49	0.001864	2.16	41.73	31.96	0.33
Reach-1	18.2*	100.00	98.36	100.52	99.67	100.59	0.001821	2.23	44.91	32.13	0.33
Reach-1	18.2*	200.00	98.36	101.34	100.15	101.46	0.001635	2.77	72.19	40.43	0.33
Reach-1	18.2*	500.00	98.36	102.49	101.09	102.66	0.001588	3.64	251.85	272.76	0.35
Reach-1	18.2*	750.00	98.36	102.98	102.11	103.15	0.001581	3.98	408.41	371.22	0.36
Reach-1	18.2*	1000.00	98.36	103.32	102.54	103.48	0.001563	4.19	543.19	403.00	0.36

Reach-1	18.2*	1500.00	98.36	103.82	103.04	103.99	0.001580	4.55	746.56	403.00	0.37
Reach-1	18	10.00	98.68	99.21	99.13	99.27	0.013104	2.00	5.00	18.94	0.69
Reach-1	18	20.00	98.68	99.41	99.28	99.48	0.009014	2.15	9.32	23.97	0.61
Reach-1	18	30.00	98.68	99.58	99.38	99.65	0.006379	2.19	13.70	26.31	0.53
Reach-1	18	40.00	98.68	99.73	99.47	99.81	0.005106	2.25	17.79	27.71	0.49
Reach-1	18	50.00	98.68	99.87	99.54	99.95	0.004338	2.29	21.80	29.13	0.47
Reach-1	18	60.00	98.68	100.00	99.60	100.09	0.003763	2.34	25.64	29.78	0.44
Reach-1	18	70.00	98.68	100.12	99.66	100.21	0.003334	2.39	29.29	29.99	0.43
Reach-1	18	80.00	98.68	100.24	99.72	100.33	0.003064	2.45	32.68	30.19	0.41
Reach-1	18	90.00	98.68	100.34	99.78	100.44	0.002853	2.50	35.97	30.38	0.41
Reach-1	18	100.00	98.68	100.45	99.83	100.55	0.002709	2.56	39.05	30.55	0.40
Reach-1	18	200.00	98.68	101.28	100.26	101.42	0.002171	3.08	65.03	31.99	0.38
Reach-1	18	500.00	98.68	102.43	101.21	102.62	0.001940	3.92	235.46	264.77	0.39
Reach-1	18	750.00	98.68	102.92	102.21	103.11	0.001839	4.20	391.53	365.23	0.39
Reach-1	18	1000.00	98.68	103.27	102.59	103.45	0.001761	4.37	528.43	402.00	0.38
Reach-1	18	1500.00	98.68	103.78	103.15	103.95	0.001716	4.67	734.10	402.00	0.39
Reach-1	17.8*	10.00	98.42	99.04	98.88	99.08	0.006745	1.71	5.86	17.08	0.51
Reach-1	17.8*	20.00	98.42	99.29	99.04	99.34	0.004891	1.88	10.65	21.06	0.47
Reach-1	17.8*	30.00	98.42	99.49	99.16	99.55	0.004204	1.97	15.20	24.83	0.44
Reach-1	17.8*	40.00	98.42	99.66	99.26	99.72	0.003537	2.05	19.54	26.50	0.42
Reach-1	17.8*	50.00	98.42	99.81	99.35	99.88	0.003146	2.11	23.67	27.99	0.40
Reach-1	17.8*	60.00	98.42	99.94	99.43	100.02	0.002900	2.17	27.59	29.34	0.40
Reach-1	17.8*	70.00	98.42	100.07	99.50	100.15	0.002723	2.23	31.43	30.73	0.39
Reach-1	17.8*	80.00	98.42	100.19	99.56	100.27	0.002524	2.28	35.09	31.19	0.38
Reach-1	17.8*	90.00	98.42	100.30	99.62	100.39	0.002350	2.33	38.62	31.39	0.37
Reach-1	17.8*	100.00	98.42	100.41	99.68	100.49	0.002237	2.39	41.89	31.56	0.37
Reach-1	17.8*	200.00	98.42	101.25	100.15	101.38	0.001845	2.89	69.09	33.00	0.35
Reach-1	17.8*	500.00	98.42	102.40	101.07	102.58	0.001751	3.78	240.81	265.80	0.37
Reach-1	17.8*	750.00	98.42	102.89	102.09	103.07	0.001707	4.10	396.36	365.62	0.37
Reach-1	17.8*	1000.00	98.42	103.24	102.51	103.41	0.001665	4.29	532.45	402.66	0.37
Reach-1	17.8*	1500.00	98.42	103.75	102.99	103.92	0.001647	4.62	738.17	402.66	0.38
Reach-1	17.6*	10.00	98.15	99.01	98.60	99.03	0.001268	1.01	9.91	18.04	0.24
Reach-1	17.6*	20.00	98.15	99.25	98.76	99.28	0.001643	1.37	14.56	20.15	0.28
Reach-1	17.6*	30.00	98.15	99.45	98.88	99.49	0.001821	1.61	18.65	21.93	0.31
Reach-1	17.6*	40.00	98.15	99.61	98.99	99.66	0.002038	1.78	22.53	24.82	0.33
Reach-1	17.6*	50.00	98.15	99.77	99.08	99.82	0.002062	1.89	26.48	26.79	0.33
Reach-1	17.6*	60.00	98.15	99.90	99.17	99.97	0.002042	1.98	30.27	28.24	0.34
Reach-1	17.6*	70.00	98.15	100.03	99.25	100.10	0.002013	2.06	34.00	29.60	0.34
Reach-1	17.6*	80.00	98.15	100.15	99.33	100.22	0.001990	2.13	37.59	30.86	0.34
Reach-1	17.6*	90.00	98.15	100.27	99.40	100.34	0.001964	2.18	41.20	32.18	0.34
Reach-1	17.6*	100.00	98.15	100.37	99.46	100.45	0.001888	2.24	44.64	32.50	0.34
Reach-1	17.6*	200.00	98.15	101.22	100.00	101.34	0.001603	2.74	72.95	34.81	0.33
Reach-1	17.6*	500.00	98.15	102.37	100.95	102.54	0.001592	3.64	247.14	268.17	0.35
Reach-1	17.6*	750.00	98.15	102.86	101.97	103.04	0.001587	3.98	403.00	367.67	0.36
Reach-1	17.6*	1000.00	98.15	103.21	102.42	103.38	0.001570	4.20	538.64	403.34	0.36
Reach-1	17.6*	1500.00	98.15	103.72	102.93	103.89	0.001576	4.55	744.24	403.34	0.37
Reach-1	17.4*	10.00	97.88	99.00	98.32	99.01	0.000382	0.69	14.40	18.46	0.14
Reach-1	17.4*	20.00	97.88	99.24	98.48	99.26	0.000683	1.05	18.99	20.05	0.19
Reach-1	17.4*	30.00	97.88	99.43	98.60	99.46	0.000898	1.31	22.95	21.44	0.22
Reach-1	17.4*	40.00	97.88	99.60	98.71	99.63	0.001060	1.51	26.54	22.62	0.25
Reach-1	17.4*	50.00	97.88	99.74	98.81	99.79	0.001240	1.66	30.05	24.83	0.27
Reach-1	17.4*	60.00	97.88	99.88	98.90	99.93	0.001376	1.79	33.56	26.90	0.28
Reach-1	17.4*	70.00	97.88	100.01	98.98	100.06	0.001440	1.89	37.09	28.34	0.29
Reach-1	17.4*	80.00	97.88	100.12	99.06	100.19	0.001490	1.97	40.51	29.66	0.30
Reach-1	17.4*	90.00	97.88	100.24	99.13	100.30	0.001521	2.05	43.96	30.94	0.30

Reach-1	17.4*	100.00	97.88	100.34	99.20	100.41	0.001548	2.11	47.31	32.14	0.31
Reach-1	17.4*	200.00	97.88	101.20	99.81	101.31	0.001426	2.61	76.56	39.31	0.31
Reach-1	17.4*	500.00	97.88	102.35	100.84	102.51	0.001452	3.50	255.30	271.36	0.34
Reach-1	17.4*	750.00	97.88	102.84	101.82	103.00	0.001474	3.86	411.72	369.76	0.35
Reach-1	17.4*	1000.00	97.88	103.18	102.33	103.34	0.001479	4.09	546.71	404.00	0.35
Reach-1	17.4*	1500.00	97.88	103.69	102.86	103.85	0.001508	4.46	751.91	404.00	0.36
Reach-1	17.2*	10.00	97.62	99.00	98.04	99.00	0.000160	0.53	18.91	18.78	0.09
Reach-1	17.2*	20.00	97.62	99.24	98.19	99.25	0.000343	0.85	23.50	20.09	0.14
Reach-1	17.2*	30.00	97.62	99.42	98.32	99.44	0.000500	1.10	27.39	21.22	0.17
Reach-1	17.2*	40.00	97.62	99.59	98.43	99.61	0.000636	1.30	30.88	22.21	0.19
Reach-1	17.2*	50.00	97.62	99.73	98.54	99.76	0.000748	1.46	34.19	23.11	0.21
Reach-1	17.2*	60.00	97.62	99.86	98.62	99.90	0.000877	1.61	37.34	24.70	0.23
Reach-1	17.2*	70.00	97.62	99.99	98.71	100.04	0.001001	1.73	40.56	26.63	0.25
Reach-1	17.2*	80.00	97.62	100.11	98.79	100.16	0.001096	1.83	43.75	28.19	0.26
Reach-1	17.2*	90.00	97.62	100.22	98.87	100.27	0.001163	1.92	46.99	29.54	0.27
Reach-1	17.2*	100.00	97.62	100.32	98.94	100.38	0.001222	1.99	50.15	30.81	0.28
Reach-1	17.2*	200.00	97.62	101.18	99.55	101.28	0.001303	2.51	79.74	42.06	0.30
Reach-1	17.2*	500.00	97.62	102.33	100.75	102.48	0.001354	3.38	261.89	274.54	0.33
Reach-1	17.2*	750.00	97.62	102.82	101.67	102.97	0.001393	3.75	419.23	372.77	0.34
Reach-1	17.2*	1000.00	97.62	103.16	102.25	103.31	0.001409	3.99	554.01	404.66	0.34
Reach-1	17.2*	1500.00	97.62	103.66	102.79	103.82	0.001454	4.38	758.76	404.66	0.36
Reach-1	17.*	10.00	97.35	99.00	97.75	99.00	0.000081	0.43	23.49	19.12	0.07
Reach-1	17.*	20.00	97.35	99.23	97.91	99.24	0.000195	0.71	28.10	20.25	0.11
Reach-1	17.*	30.00	97.35	99.42	98.04	99.43	0.000304	0.94	31.97	21.20	0.13
Reach-1	17.*	40.00	97.35	99.58	98.15	99.60	0.000407	1.13	35.42	22.07	0.16
Reach-1	17.*	50.00	97.35	99.72	98.25	99.75	0.000498	1.29	38.67	22.85	0.18
Reach-1	17.*	60.00	97.35	99.86	98.36	99.89	0.000582	1.44	41.71	23.56	0.19
Reach-1	17.*	70.00	97.35	99.98	98.44	100.02	0.000670	1.57	44.67	24.65	0.21
Reach-1	17.*	80.00	97.35	100.09	98.52	100.14	0.000770	1.68	47.57	26.25	0.22
Reach-1	17.*	90.00	97.35	100.20	98.60	100.25	0.000858	1.78	50.56	27.81	0.23
Reach-1	17.*	100.00	97.35	100.31	98.67	100.36	0.000934	1.87	53.50	29.17	0.24
Reach-1	17.*	200.00	97.35	101.16	99.29	101.25	0.001210	2.42	82.72	45.04	0.29
Reach-1	17.*	500.00	97.35	102.31	100.63	102.45	0.001273	3.28	268.57	277.96	0.31
Reach-1	17.*	750.00	97.35	102.80	101.50	102.94	0.001323	3.65	427.01	376.04	0.33
Reach-1	17.*	1000.00	97.35	103.13	102.17	103.28	0.001346	3.90	561.68	405.34	0.34
Reach-1	17.*	1500.00	97.35	103.64	102.74	103.79	0.001406	4.30	765.92	405.34	0.35
Reach-1	16.8	10.00	97.09	99.00	97.47	99.00	0.000047	0.36	28.03	19.41	0.05
Reach-1	16.8	20.00	97.09	99.23	97.63	99.24	0.000121	0.61	32.68	20.42	0.09
Reach-1	16.8	30.00	97.09	99.42	97.76	99.43	0.000199	0.82	36.55	21.24	0.11
Reach-1	16.8	40.00	97.09	99.58	97.87	99.59	0.000276	1.00	39.97	22.00	0.13
Reach-1	16.8	50.00	97.09	99.72	97.98	99.74	0.000349	1.16	43.18	22.69	0.15
Reach-1	16.8	60.00	97.09	99.85	98.08	99.88	0.000418	1.30	46.17	23.32	0.16
Reach-1	16.8	70.00	97.09	99.97	98.16	100.00	0.000481	1.43	49.06	23.91	0.18
Reach-1	16.8	80.00	97.09	100.08	98.25	100.12	0.000542	1.54	51.79	24.45	0.19
Reach-1	16.8	90.00	97.09	100.19	98.33	100.24	0.000621	1.65	54.53	25.88	0.20
Reach-1	16.8	100.00	97.09	100.30	98.41	100.34	0.000698	1.75	57.23	27.25	0.21
Reach-1	16.8	200.00	97.09	101.14	99.04	101.23	0.001148	2.35	85.30	48.10	0.28
Reach-1	16.8	500.00	97.09	102.29	100.42	102.42	0.001213	3.19	274.59	280.84	0.31
Reach-1	16.8	750.00	97.09	102.77	101.34	102.91	0.001270	3.56	433.86	378.53	0.32
Reach-1	16.8	1000.00	97.09	103.11	102.10	103.25	0.001300	3.81	568.26	406.00	0.33
Reach-1	16.8	1500.00	97.09	103.61	102.68	103.76	0.001370	4.22	771.99	406.00	0.34
Reach-1	16.6*	10.00	97.40	99.00	97.81	99.00	0.000092	0.44	22.73	19.37	0.07
Reach-1	16.6*	20.00	97.40	99.23	97.97	99.23	0.000216	0.73	27.32	20.56	0.11
Reach-1	16.6*	30.00	97.40	99.41	98.10	99.42	0.000337	0.96	31.16	21.61	0.14
Reach-1	16.6*	40.00	97.40	99.56	98.21	99.58	0.000448	1.16	34.58	22.50	0.16

Reach-1	16.6*	50.00	97.40	99.70	98.31	99.73	0.000547	1.32	37.80	23.31	0.18
Reach-1	16.6*	60.00	97.40	99.83	98.41	99.86	0.000654	1.47	40.84	24.60	0.20
Reach-1	16.6*	70.00	97.40	99.95	98.49	99.99	0.000767	1.59	43.89	26.36	0.22
Reach-1	16.6*	80.00	97.40	100.06	98.57	100.11	0.000867	1.71	46.91	27.96	0.23
Reach-1	16.6*	90.00	97.40	100.17	98.65	100.22	0.000945	1.80	49.98	29.28	0.24
Reach-1	16.6*	100.00	97.40	100.27	98.73	100.33	0.001014	1.89	52.98	30.52	0.25
Reach-1	16.6*	200.00	97.40	101.11	99.34	101.20	0.001210	2.44	82.33	48.46	0.29
Reach-1	16.6*	500.00	97.40	102.26	100.63	102.40	0.001267	3.29	271.19	280.41	0.31
Reach-1	16.6*	750.00	97.40	102.74	101.50	102.89	0.001317	3.66	430.01	377.86	0.33
Reach-1	16.6*	1000.00	97.40	103.08	102.13	103.22	0.001339	3.90	564.45	405.00	0.34
Reach-1	16.6*	1500.00	97.40	103.58	102.68	103.73	0.001405	4.31	767.33	405.00	0.35
Reach-1	16.4*	10.00	97.72	98.99	98.16	99.00	0.000223	0.58	17.31	19.45	0.11
Reach-1	16.4*	20.00	97.72	99.21	98.32	99.23	0.000459	0.92	21.84	21.02	0.16
Reach-1	16.4*	30.00	97.72	99.39	98.44	99.41	0.000654	1.17	25.67	22.31	0.19
Reach-1	16.4*	40.00	97.72	99.54	98.55	99.57	0.000851	1.37	29.14	24.21	0.22
Reach-1	16.4*	50.00	97.72	99.68	98.65	99.72	0.001032	1.53	32.63	26.56	0.24
Reach-1	16.4*	60.00	97.72	99.80	98.73	99.85	0.001144	1.67	36.02	27.94	0.26
Reach-1	16.4*	70.00	97.72	99.92	98.82	99.97	0.001229	1.78	39.39	29.24	0.27
Reach-1	16.4*	80.00	97.72	100.03	98.89	100.09	0.001301	1.88	42.65	30.44	0.28
Reach-1	16.4*	90.00	97.72	100.14	98.97	100.20	0.001351	1.96	45.95	31.61	0.29
Reach-1	16.4*	100.00	97.72	100.24	99.04	100.30	0.001401	2.03	49.15	32.80	0.29
Reach-1	16.4*	200.00	97.72	101.07	99.65	101.18	0.001351	2.57	78.05	45.63	0.30
Reach-1	16.4*	500.00	97.72	102.22	100.67	102.37	0.001386	3.44	262.93	277.23	0.33
Reach-1	16.4*	750.00	97.72	102.70	101.65	102.86	0.001420	3.80	420.44	374.92	0.34
Reach-1	16.4*	1000.00	97.72	103.04	102.17	103.20	0.001427	4.03	555.09	404.00	0.35
Reach-1	16.4*	1500.00	97.72	103.54	102.69	103.70	0.001477	4.42	757.73	404.00	0.36
Reach-1	16.2*	10.00	98.03	98.98	98.49	98.99	0.000835	0.85	11.70	19.96	0.20
Reach-1	16.2*	20.00	98.03	99.19	98.65	99.21	0.001347	1.24	16.19	22.68	0.26
Reach-1	16.2*	30.00	98.03	99.36	98.77	99.39	0.001677	1.48	20.30	25.58	0.29
Reach-1	16.2*	40.00	98.03	99.50	98.87	99.55	0.001813	1.66	24.12	27.07	0.31
Reach-1	16.2*	50.00	98.03	99.64	98.96	99.69	0.001881	1.80	27.84	28.44	0.32
Reach-1	16.2*	60.00	98.03	99.76	99.05	99.82	0.001923	1.91	31.41	29.70	0.33
Reach-1	16.2*	70.00	98.03	99.88	99.12	99.94	0.001937	2.00	34.95	30.93	0.33
Reach-1	16.2*	80.00	98.03	99.99	99.20	100.05	0.001925	2.08	38.38	31.77	0.33
Reach-1	16.2*	90.00	98.03	100.09	99.28	100.16	0.001858	2.15	41.77	31.95	0.33
Reach-1	16.2*	100.00	98.03	100.19	99.34	100.27	0.001816	2.23	44.94	32.12	0.33
Reach-1	16.2*	200.00	98.03	101.03	99.82	101.14	0.001614	2.76	72.48	40.74	0.33
Reach-1	16.2*	500.00	98.03	102.17	100.76	102.34	0.001582	3.63	252.04	273.09	0.35
Reach-1	16.2*	750.00	98.03	102.66	101.78	102.83	0.001575	3.97	408.97	371.90	0.36
Reach-1	16.2*	1000.00	98.03	103.00	102.22	103.16	0.001549	4.17	544.89	403.00	0.36
Reach-1	16.2*	1500.00	98.03	103.50	102.71	103.67	0.001571	4.54	747.97	403.00	0.37
Reach-1	16	10.00	98.35	98.88	98.80	98.94	0.013259	2.01	4.98	18.89	0.69
Reach-1	16	20.00	98.35	99.08	98.95	99.15	0.008572	2.11	9.49	24.10	0.59
Reach-1	16	30.00	98.35	99.26	99.05	99.33	0.006029	2.15	13.96	26.40	0.52
Reach-1	16	40.00	98.35	99.41	99.14	99.49	0.004868	2.21	18.07	27.80	0.48
Reach-1	16	50.00	98.35	99.55	99.21	99.63	0.004190	2.27	22.06	29.22	0.46
Reach-1	16	60.00	98.35	99.68	99.27	99.76	0.003664	2.32	25.85	29.79	0.44
Reach-1	16	70.00	98.35	99.80	99.33	99.89	0.003271	2.38	29.47	30.00	0.42
Reach-1	16	80.00	98.35	99.91	99.39	100.00	0.003023	2.44	32.82	30.19	0.41
Reach-1	16	90.00	98.35	100.02	99.45	100.12	0.002811	2.49	36.13	30.39	0.40
Reach-1	16	100.00	98.35	100.12	99.50	100.22	0.002676	2.55	39.20	30.56	0.40
Reach-1	16	200.00	98.35	100.96	99.93	101.10	0.002126	3.06	65.46	34.02	0.38
Reach-1	16	500.00	98.35	102.11	100.88	102.30	0.001896	3.89	238.91	267.40	0.38
Reach-1	16	750.00	98.35	102.61	101.88	102.79	0.001798	4.17	396.39	367.92	0.38
Reach-1	16	1000.00	98.35	102.96	102.26	103.13	0.001711	4.32	534.83	402.00	0.38
Reach-1	16	1500.00	98.35	103.47	102.82	103.63	0.001682	4.63	739.61	402.00	0.38

Reach-1	15.8*	10.00	98.08	98.73	98.54	98.77	0.005418	1.58	6.34	17.64	0.46
Reach-1	15.8*	20.00	98.08	98.98	98.71	99.03	0.004264	1.79	11.16	21.34	0.44
Reach-1	15.8*	30.00	98.08	99.18	98.83	99.23	0.003788	1.91	15.73	25.02	0.42
Reach-1	15.8*	40.00	98.08	99.34	98.93	99.40	0.003290	2.00	20.02	26.65	0.41
Reach-1	15.8*	50.00	98.08	99.49	99.01	99.56	0.002991	2.08	24.07	28.11	0.40
Reach-1	15.8*	60.00	98.08	99.62	99.10	99.69	0.002796	2.15	27.93	29.43	0.39
Reach-1	15.8*	70.00	98.08	99.75	99.17	99.82	0.002650	2.21	31.72	30.81	0.38
Reach-1	15.8*	80.00	98.08	99.87	99.23	99.94	0.002469	2.26	35.33	31.20	0.38
Reach-1	15.8*	90.00	98.08	99.98	99.29	100.06	0.002298	2.31	38.89	31.40	0.37
Reach-1	15.8*	100.00	98.08	100.08	99.34	100.17	0.002195	2.37	42.14	31.57	0.36
Reach-1	15.8*	200.00	98.08	100.93	99.82	101.06	0.001799	2.87	69.63	35.62	0.35
Reach-1	15.8*	500.00	98.08	102.08	100.74	102.26	0.001708	3.74	244.54	268.58	0.37
Reach-1	15.8*	750.00	98.08	102.58	101.76	102.75	0.001665	4.06	401.66	368.51	0.37
Reach-1	15.8*	1000.00	98.08	102.93	102.17	103.09	0.001614	4.24	539.41	402.66	0.37
Reach-1	15.8*	1500.00	98.08	103.43	102.66	103.60	0.001611	4.58	744.08	402.66	0.38
Reach-1	15.6*	10.00	97.82	98.71	98.27	98.72	0.001093	0.96	10.43	18.30	0.22
Reach-1	15.6*	20.00	97.82	98.95	98.43	98.98	0.001492	1.33	15.06	20.38	0.27
Reach-1	15.6*	30.00	97.82	99.14	98.55	99.18	0.001695	1.57	19.13	22.12	0.30
Reach-1	15.6*	40.00	97.82	99.30	98.66	99.35	0.001944	1.74	22.97	25.15	0.32
Reach-1	15.6*	50.00	97.82	99.45	98.75	99.50	0.001983	1.86	26.85	26.94	0.33
Reach-1	15.6*	60.00	97.82	99.58	98.84	99.64	0.001987	1.96	30.57	28.35	0.33
Reach-1	15.6*	70.00	97.82	99.71	98.92	99.78	0.001973	2.04	34.24	29.68	0.34
Reach-1	15.6*	80.00	97.82	99.83	98.99	99.90	0.001963	2.12	37.79	30.93	0.34
Reach-1	15.6*	90.00	97.82	99.94	99.06	100.02	0.001935	2.17	41.43	32.26	0.34
Reach-1	15.6*	100.00	97.82	100.05	99.13	100.13	0.001860	2.23	44.85	32.51	0.33
Reach-1	15.6*	200.00	97.82	100.91	99.67	101.02	0.001567	2.72	73.48	37.78	0.33
Reach-1	15.6*	500.00	97.82	102.06	100.62	102.22	0.001554	3.60	251.02	271.10	0.35
Reach-1	15.6*	750.00	97.82	102.55	101.64	102.72	0.001548	3.94	408.59	370.75	0.36
Reach-1	15.6*	1000.00	97.82	102.90	102.09	103.06	0.001520	4.14	546.07	403.34	0.36
Reach-1	15.6*	1500.00	97.82	103.40	102.60	103.57	0.001542	4.51	750.45	403.34	0.37
Reach-1	15.4*	10.00	97.56	98.70	98.00	98.71	0.000348	0.67	14.87	18.65	0.13
Reach-1	15.4*	20.00	97.56	98.94	98.16	98.95	0.000640	1.03	19.44	20.23	0.18
Reach-1	15.4*	30.00	97.56	99.12	98.28	99.15	0.000854	1.28	23.37	21.60	0.22
Reach-1	15.4*	40.00	97.56	99.28	98.39	99.32	0.001023	1.49	26.89	22.75	0.24
Reach-1	15.4*	50.00	97.56	99.43	98.49	99.47	0.001216	1.65	30.34	25.06	0.26
Reach-1	15.4*	60.00	97.56	99.56	98.57	99.61	0.001353	1.78	33.79	27.02	0.28
Reach-1	15.4*	70.00	97.56	99.69	98.66	99.74	0.001423	1.88	37.26	28.43	0.29
Reach-1	15.4*	80.00	97.56	99.80	98.73	99.86	0.001480	1.97	40.64	29.74	0.30
Reach-1	15.4*	90.00	97.56	99.92	98.81	99.98	0.001507	2.04	44.12	31.03	0.30
Reach-1	15.4*	100.00	97.56	100.02	98.88	100.09	0.001537	2.11	47.45	32.22	0.31
Reach-1	15.4*	200.00	97.56	100.89	99.48	100.99	0.001397	2.60	77.12	42.37	0.31
Reach-1	15.4*	500.00	97.56	102.04	100.51	102.19	0.001417	3.46	259.79	275.10	0.33
Reach-1	15.4*	750.00	97.56	102.53	101.50	102.68	0.001435	3.82	418.51	374.00	0.34
Reach-1	15.4*	1000.00	97.56	102.87	102.00	103.03	0.001425	4.03	555.78	404.00	0.35
Reach-1	15.4*	1500.00	97.56	103.38	102.53	103.54	0.001469	4.41	759.56	404.00	0.36
Reach-1	15.2*	10.00	97.29	98.70	97.71	98.70	0.000148	0.51	19.46	18.95	0.09
Reach-1	15.2*	20.00	97.29	98.93	97.86	98.94	0.000322	0.83	24.02	20.23	0.13
Reach-1	15.2*	30.00	97.29	99.12	97.99	99.14	0.000476	1.08	27.87	21.36	0.17
Reach-1	15.2*	40.00	97.29	99.27	98.10	99.30	0.000612	1.28	31.29	22.33	0.19
Reach-1	15.2*	50.00	97.29	99.42	98.21	99.45	0.000728	1.45	34.53	23.20	0.21
Reach-1	15.2*	60.00	97.29	99.55	98.29	99.58	0.000864	1.59	37.62	24.88	0.23
Reach-1	15.2*	70.00	97.29	99.67	98.38	99.71	0.000989	1.72	40.79	26.76	0.24
Reach-1	15.2*	80.00	97.29	99.78	98.46	99.83	0.001085	1.82	43.93	28.27	0.26
Reach-1	15.2*	90.00	97.29	99.90	98.54	99.95	0.001150	1.91	47.22	29.64	0.27
Reach-1	15.2*	100.00	97.29	100.00	98.61	100.06	0.001210	1.99	50.36	30.89	0.27

Reach-1	15.2*	200.00	97.29	100.87	99.22	100.96	0.001273	2.49	80.43	45.24	0.29
Reach-1	15.2*	500.00	97.29	102.02	100.42	102.16	0.001320	3.35	266.20	277.70	0.32
Reach-1	15.2*	750.00	97.29	102.50	101.34	102.65	0.001356	3.72	425.50	376.14	0.33
Reach-1	15.2*	1000.00	97.29	102.85	101.92	103.00	0.001360	3.94	562.38	404.66	0.34
Reach-1	15.2*	1500.00	97.29	103.35	102.46	103.51	0.001420	4.34	765.64	404.66	0.35
Reach-1	15.*	10.00	97.03	98.70	97.43	98.70	0.000077	0.42	23.99	19.26	0.07
Reach-1	15.*	20.00	97.03	98.93	97.58	98.94	0.000186	0.70	28.56	20.38	0.10
Reach-1	15.*	30.00	97.03	99.11	97.71	99.13	0.000293	0.93	32.40	21.33	0.13
Reach-1	15.*	40.00	97.03	99.27	97.83	99.29	0.000396	1.12	35.77	22.17	0.16
Reach-1	15.*	50.00	97.03	99.41	97.93	99.43	0.000489	1.28	38.95	22.93	0.17
Reach-1	15.*	60.00	97.03	99.54	98.03	99.57	0.000575	1.43	41.91	23.62	0.19
Reach-1	15.*	70.00	97.03	99.66	98.11	99.70	0.000666	1.56	44.82	24.77	0.20
Reach-1	15.*	80.00	97.03	99.77	98.20	99.81	0.000768	1.68	47.68	26.35	0.22
Reach-1	15.*	90.00	97.03	99.88	98.27	99.93	0.000854	1.77	50.71	27.92	0.23
Reach-1	15.*	100.00	97.03	99.98	98.35	100.04	0.000929	1.86	53.64	29.26	0.24
Reach-1	15.*	200.00	97.03	100.85	98.98	100.94	0.001184	2.41	83.42	48.32	0.28
Reach-1	15.*	500.00	97.03	102.00	100.30	102.13	0.001242	3.25	273.02	281.23	0.31
Reach-1	15.*	750.00	97.03	102.48	101.17	102.63	0.001288	3.62	433.54	379.57	0.32
Reach-1	15.*	1000.00	97.03	102.82	101.85	102.97	0.001300	3.84	570.43	405.34	0.33
Reach-1	15.*	1500.00	97.03	103.32	102.41	103.48	0.001372	4.25	773.07	405.34	0.34
Reach-1	14.8	10.00	96.76	98.70	97.14	98.70	0.000044	0.35	28.60	19.53	0.05
Reach-1	14.8	20.00	96.76	98.93	97.30	98.93	0.000116	0.60	33.21	20.53	0.08
Reach-1	14.8	30.00	96.76	99.11	97.43	99.12	0.000192	0.81	37.04	21.35	0.11
Reach-1	14.8	40.00	96.76	99.26	97.54	99.28	0.000269	0.99	40.39	22.09	0.13
Reach-1	14.8	50.00	96.76	99.40	97.65	99.43	0.000341	1.15	43.52	22.76	0.15
Reach-1	14.8	60.00	96.76	99.53	97.75	99.56	0.000411	1.29	46.44	23.37	0.16
Reach-1	14.8	70.00	96.76	99.65	97.83	99.68	0.000476	1.42	49.27	23.95	0.17
Reach-1	14.8	80.00	96.76	99.76	97.92	99.80	0.000537	1.54	51.95	24.49	0.19
Reach-1	14.8	90.00	96.76	99.87	98.00	99.91	0.000617	1.64	54.73	25.98	0.20
Reach-1	14.8	100.00	96.76	99.97	98.07	100.02	0.000694	1.74	57.41	27.35	0.21
Reach-1	14.8	200.00	96.76	100.83	98.71	100.91	0.001119	2.33	86.14	51.49	0.27
Reach-1	14.8	500.00	96.76	101.98	100.09	102.10	0.001181	3.16	279.32	284.22	0.30
Reach-1	14.8	750.00	96.76	102.46	101.01	102.60	0.001234	3.53	440.76	382.20	0.31
Reach-1	14.8	1000.00	96.76	102.80	101.77	102.94	0.001252	3.75	577.46	406.00	0.32
Reach-1	14.8	1500.00	96.76	103.30	102.34	103.45	0.001335	4.18	779.47	406.00	0.34
Reach-1	14.6*	10.00	97.08	98.70	97.49	98.70	0.000087	0.43	23.17	19.47	0.07
Reach-1	14.6*	20.00	97.08	98.92	97.64	98.93	0.000208	0.72	27.71	20.64	0.11
Reach-1	14.6*	30.00	97.08	99.10	97.77	99.12	0.000326	0.95	31.51	21.68	0.14
Reach-1	14.6*	40.00	97.08	99.25	97.89	99.27	0.000438	1.15	34.85	22.55	0.16
Reach-1	14.6*	50.00	97.08	99.39	97.99	99.42	0.000539	1.32	37.98	23.34	0.18
Reach-1	14.6*	60.00	97.08	99.51	98.08	99.55	0.000650	1.47	40.93	24.61	0.20
Reach-1	14.6*	70.00	97.08	99.63	98.17	99.67	0.000765	1.59	43.92	26.34	0.22
Reach-1	14.6*	80.00	97.08	99.74	98.26	99.78	0.000868	1.71	46.87	27.91	0.23
Reach-1	14.6*	90.00	97.08	99.85	98.33	99.90	0.000944	1.80	49.97	29.25	0.24
Reach-1	14.6*	100.00	97.08	99.95	98.40	100.00	0.001015	1.89	52.94	30.47	0.25
Reach-1	14.6*	200.00	97.08	100.80	99.01	100.89	0.001195	2.43	82.74	49.84	0.29
Reach-1	14.6*	500.00	97.08	101.94	100.30	102.08	0.001253	3.27	273.15	282.14	0.31
Reach-1	14.6*	750.00	97.08	102.43	101.18	102.57	0.001300	3.64	433.39	380.13	0.33
Reach-1	14.6*	1000.00	97.08	102.77	101.81	102.91	0.001309	3.87	570.03	405.00	0.33
Reach-1	14.6*	1500.00	97.08	103.27	102.36	103.42	0.001386	4.28	771.29	405.00	0.35
Reach-1	14.4*	10.00	97.40	98.69	97.84	98.70	0.000213	0.57	17.59	19.57	0.11
Reach-1	14.4*	20.00	97.40	98.91	98.00	98.92	0.000446	0.91	22.07	21.13	0.16
Reach-1	14.4*	30.00	97.40	99.09	98.12	99.11	0.000641	1.16	25.87	22.40	0.19
Reach-1	14.4*	40.00	97.40	99.23	98.23	99.26	0.000844	1.37	29.25	24.29	0.22
Reach-1	14.4*	50.00	97.40	99.36	98.33	99.40	0.001027	1.53	32.62	26.47	0.24

Reach-1	14.4*	60.00	97.40	99.48	98.42	99.53	0.001152	1.67	35.91	27.86	0.26
Reach-1	14.4*	70.00	97.40	99.60	98.50	99.65	0.001246	1.79	39.18	29.15	0.27
Reach-1	14.4*	80.00	97.40	99.71	98.58	99.76	0.001325	1.89	42.36	30.35	0.28
Reach-1	14.4*	90.00	97.40	99.81	98.65	99.87	0.001374	1.97	45.68	31.56	0.29
Reach-1	14.4*	100.00	97.40	99.91	98.72	99.98	0.001423	2.05	48.84	32.68	0.30
Reach-1	14.4*	200.00	97.40	100.76	99.33	100.86	0.001349	2.57	78.05	44.90	0.30
Reach-1	14.4*	500.00	97.40	101.90	100.36	102.05	0.001394	3.44	261.94	277.13	0.33
Reach-1	14.4*	750.00	97.40	102.39	101.34	102.54	0.001424	3.81	420.07	375.65	0.34
Reach-1	14.4*	1000.00	97.40	102.73	101.85	102.88	0.001417	4.02	556.80	404.00	0.35
Reach-1	14.4*	1500.00	97.40	103.23	102.38	103.39	0.001476	4.42	757.98	404.00	0.36
Reach-1	14.2*	10.00	97.73	98.68	98.19	98.69	0.000817	0.85	11.79	20.04	0.19
Reach-1	14.2*	20.00	97.73	98.88	98.35	98.91	0.001341	1.23	16.21	22.66	0.26
Reach-1	14.2*	30.00	97.73	99.05	98.47	99.09	0.001694	1.48	20.25	25.60	0.29
Reach-1	14.2*	40.00	97.73	99.19	98.57	99.23	0.001856	1.67	23.94	27.01	0.31
Reach-1	14.2*	50.00	97.73	99.32	98.66	99.37	0.001947	1.82	27.50	28.31	0.33
Reach-1	14.2*	60.00	97.73	99.44	98.74	99.50	0.002008	1.94	30.92	29.50	0.33
Reach-1	14.2*	70.00	97.73	99.55	98.82	99.62	0.002037	2.04	34.33	30.71	0.34
Reach-1	14.2*	80.00	97.73	99.66	98.90	99.73	0.002048	2.13	37.65	31.74	0.34
Reach-1	14.2*	90.00	97.73	99.77	98.97	99.84	0.001960	2.19	41.08	31.92	0.34
Reach-1	14.2*	100.00	97.73	99.86	99.04	99.94	0.001913	2.26	44.22	32.09	0.34
Reach-1	14.2*	200.00	97.73	100.71	99.52	100.83	0.001640	2.78	72.09	39.62	0.33
Reach-1	14.2*	500.00	97.73	101.85	100.46	102.02	0.001617	3.66	248.78	270.43	0.36
Reach-1	14.2*	750.00	97.73	102.34	101.47	102.51	0.001606	4.00	404.76	369.19	0.36
Reach-1	14.2*	1000.00	97.73	102.69	101.91	102.85	0.001570	4.20	542.03	403.00	0.36
Reach-1	14.2*	1500.00	97.73	103.19	102.41	103.35	0.001593	4.56	744.10	403.00	0.37
Reach-1	14	10.00	98.05	98.58	98.50	98.64	0.013131	2.00	5.00	18.93	0.69
Reach-1	14	20.00	98.05	98.78	98.65	98.85	0.009067	2.15	9.31	23.95	0.61
Reach-1	14	30.00	98.05	98.95	98.75	99.02	0.006484	2.20	13.63	26.29	0.54
Reach-1	14	40.00	98.05	99.09	98.84	99.17	0.005328	2.28	17.54	27.63	0.50
Reach-1	14	50.00	98.05	99.23	98.91	99.31	0.004630	2.34	21.33	28.96	0.48
Reach-1	14	60.00	98.05	99.35	98.97	99.44	0.004110	2.40	24.95	29.74	0.46
Reach-1	14	70.00	98.05	99.47	99.03	99.56	0.003655	2.46	28.47	29.94	0.44
Reach-1	14	80.00	98.05	99.57	99.09	99.67	0.003370	2.52	31.72	30.13	0.43
Reach-1	14	90.00	98.05	99.69	99.15	99.79	0.003078	2.56	35.12	30.33	0.42
Reach-1	14	100.00	98.05	99.79	99.20	99.89	0.002914	2.62	38.17	30.50	0.41
Reach-1	14	200.00	98.05	100.64	99.63	100.79	0.002187	3.08	64.88	31.99	0.38
Reach-1	14	500.00	98.05	101.78	100.58	101.98	0.001988	3.96	231.81	261.95	0.39
Reach-1	14	750.00	98.05	102.28	101.59	102.47	0.001877	4.24	387.23	362.84	0.39
Reach-1	14	1000.00	98.05	102.64	101.96	102.82	0.001772	4.38	527.07	402.00	0.38
Reach-1	14	1500.00	98.05	103.15	102.52	103.32	0.001733	4.69	731.44	402.00	0.39
Reach-1	13.8*	10.00	97.79	98.41	98.25	98.46	0.006639	1.70	5.90	17.13	0.51
Reach-1	13.8*	20.00	97.79	98.66	98.41	98.71	0.004917	1.89	10.61	20.94	0.47
Reach-1	13.8*	30.00	97.79	98.85	98.53	98.91	0.004356	2.00	15.02	24.77	0.45
Reach-1	13.8*	40.00	97.79	99.01	98.63	99.08	0.003757	2.09	19.15	26.36	0.43
Reach-1	13.8*	50.00	97.79	99.15	98.72	99.23	0.003413	2.17	23.02	27.77	0.42
Reach-1	13.8*	60.00	97.79	99.28	98.80	99.36	0.003193	2.25	26.69	29.04	0.41
Reach-1	13.8*	70.00	97.79	99.41	98.87	99.49	0.003001	2.30	30.37	30.36	0.41
Reach-1	13.8*	80.00	97.79	99.52	98.93	99.61	0.002825	2.36	33.88	31.13	0.40
Reach-1	13.8*	90.00	97.79	99.64	98.99	99.73	0.002565	2.40	37.58	31.33	0.39
Reach-1	13.8*	100.00	97.79	99.74	99.05	99.84	0.002428	2.45	40.83	31.51	0.38
Reach-1	13.8*	200.00	97.79	100.61	99.52	100.74	0.001862	2.90	68.89	32.99	0.35
Reach-1	13.8*	500.00	97.79	101.75	100.44	101.94	0.001797	3.81	236.87	262.81	0.37
Reach-1	13.8*	750.00	97.79	102.25	101.46	102.43	0.001744	4.13	391.70	363.04	0.38
Reach-1	13.8*	1000.00	97.79	102.60	101.88	102.78	0.001676	4.30	530.95	402.66	0.38
Reach-1	13.8*	1500.00	97.79	103.11	102.36	103.28	0.001664	4.64	735.29	402.66	0.38

Reach-1	13.6*	10.00	97.52	98.38	97.97	98.40	0.001274	1.01	9.90	18.05	0.24
Reach-1	13.6*	20.00	97.52	98.62	98.14	98.65	0.001673	1.38	14.47	20.13	0.29
Reach-1	13.6*	30.00	97.52	98.81	98.26	98.85	0.001881	1.63	18.44	21.86	0.31
Reach-1	13.6*	40.00	97.52	98.97	98.37	99.02	0.002141	1.81	22.09	24.51	0.34
Reach-1	13.6*	50.00	97.52	99.11	98.46	99.17	0.002230	1.94	25.75	26.50	0.35
Reach-1	13.6*	60.00	97.52	99.24	98.54	99.31	0.002240	2.05	29.27	27.84	0.35
Reach-1	13.6*	70.00	97.52	99.37	98.62	99.44	0.002212	2.13	32.83	29.13	0.35
Reach-1	13.6*	80.00	97.52	99.48	98.69	99.56	0.002197	2.21	36.23	30.31	0.36
Reach-1	13.6*	90.00	97.52	99.60	98.76	99.68	0.002124	2.25	39.98	31.66	0.35
Reach-1	13.6*	100.00	97.52	99.71	98.83	99.79	0.002067	2.31	43.38	32.43	0.35
Reach-1	13.6*	200.00	97.52	100.59	99.37	100.71	0.001623	2.75	72.68	34.00	0.33
Reach-1	13.6*	500.00	97.52	101.73	100.32	101.90	0.001640	3.68	242.45	264.32	0.36
Reach-1	13.6*	750.00	97.52	102.22	101.33	102.40	0.001628	4.02	397.01	363.92	0.37
Reach-1	13.6*	1000.00	97.52	102.57	101.79	102.74	0.001590	4.22	535.67	403.34	0.37
Reach-1	13.6*	1500.00	97.52	103.08	102.30	103.25	0.001600	4.57	739.93	403.34	0.37
Reach-1	13.4*	10.00	97.26	98.37	97.70	98.38	0.000386	0.70	14.34	18.43	0.14
Reach-1	13.4*	20.00	97.26	98.61	97.86	98.63	0.000697	1.06	18.85	19.96	0.19
Reach-1	13.4*	30.00	97.26	98.79	97.98	98.82	0.000928	1.32	22.67	21.31	0.23
Reach-1	13.4*	40.00	97.26	98.95	98.09	98.98	0.001118	1.54	26.03	22.43	0.25
Reach-1	13.4*	50.00	97.26	99.09	98.19	99.13	0.001319	1.71	29.24	24.28	0.27
Reach-1	13.4*	60.00	97.26	99.21	98.27	99.27	0.001505	1.85	32.44	26.44	0.29
Reach-1	13.4*	70.00	97.26	99.34	98.36	99.40	0.001582	1.96	35.80	27.85	0.30
Reach-1	13.4*	80.00	97.26	99.45	98.43	99.51	0.001645	2.05	39.02	29.10	0.31
Reach-1	13.4*	90.00	97.26	99.57	98.51	99.64	0.001649	2.11	42.62	30.43	0.31
Reach-1	13.4*	100.00	97.26	99.68	98.58	99.75	0.001674	2.18	45.89	31.59	0.32
Reach-1	13.4*	200.00	97.26	100.57	99.19	100.67	0.001452	2.63	76.12	36.06	0.31
Reach-1	13.4*	500.00	97.26	101.70	100.21	101.87	0.001513	3.55	248.63	266.95	0.34
Reach-1	13.4*	750.00	97.26	102.19	101.19	102.36	0.001529	3.91	403.69	366.26	0.35
Reach-1	13.4*	1000.00	97.26	102.55	101.71	102.71	0.001508	4.12	542.26	404.00	0.36
Reach-1	13.4*	1500.00	97.26	103.05	102.24	103.22	0.001539	4.50	746.17	404.00	0.37
Reach-1	13.2*	10.00	97.00	98.37	97.42	98.38	0.000164	0.53	18.78	18.78	0.09
Reach-1	13.2*	20.00	97.00	98.60	97.57	98.61	0.000353	0.86	23.28	20.07	0.14
Reach-1	13.2*	30.00	97.00	98.79	97.70	98.81	0.000519	1.11	27.05	21.15	0.17
Reach-1	13.2*	40.00	97.00	98.94	97.81	98.96	0.000670	1.32	30.32	22.07	0.20
Reach-1	13.2*	50.00	97.00	99.07	97.92	99.11	0.000800	1.50	33.37	22.89	0.22
Reach-1	13.2*	60.00	97.00	99.20	98.00	99.24	0.000932	1.66	36.24	23.98	0.24
Reach-1	13.2*	70.00	97.00	99.32	98.09	99.37	0.001073	1.78	39.25	25.83	0.25
Reach-1	13.2*	80.00	97.00	99.43	98.17	99.48	0.001195	1.90	42.20	27.50	0.27
Reach-1	13.2*	90.00	97.00	99.55	98.25	99.61	0.001253	1.97	45.58	28.94	0.28
Reach-1	13.2*	100.00	97.00	99.65	98.32	99.72	0.001316	2.06	48.66	30.20	0.29
Reach-1	13.2*	200.00	97.00	100.54	98.92	100.64	0.001333	2.53	79.13	38.66	0.30
Reach-1	13.2*	500.00	97.00	101.68	100.13	101.83	0.001418	3.44	254.29	269.19	0.33
Reach-1	13.2*	750.00	97.00	102.17	101.04	102.33	0.001452	3.82	409.68	368.00	0.34
Reach-1	13.2*	1000.00	97.00	102.52	101.63	102.68	0.001445	4.04	547.96	404.66	0.35
Reach-1	13.2*	1500.00	97.00	103.02	102.17	103.19	0.001492	4.42	751.46	404.66	0.36
Reach-1	13.*	10.00	96.73	98.37	97.13	98.37	0.000083	0.43	23.36	19.08	0.07
Reach-1	13.*	20.00	96.73	98.60	97.29	98.61	0.000199	0.72	27.88	20.19	0.11
Reach-1	13.*	30.00	96.73	98.78	97.42	98.80	0.000314	0.95	31.62	21.10	0.14
Reach-1	13.*	40.00	96.73	98.93	97.53	98.95	0.000426	1.15	34.83	21.91	0.16
Reach-1	13.*	50.00	96.73	99.07	97.63	99.09	0.000529	1.32	37.83	22.64	0.18
Reach-1	13.*	60.00	96.73	99.19	97.73	99.22	0.000626	1.48	40.62	23.30	0.20
Reach-1	13.*	70.00	96.73	99.31	97.81	99.35	0.000708	1.61	43.43	23.94	0.21
Reach-1	13.*	80.00	96.73	99.41	97.90	99.46	0.000821	1.74	46.10	25.44	0.23
Reach-1	13.*	90.00	96.73	99.53	97.98	99.58	0.000908	1.83	49.20	27.09	0.24
Reach-1	13.*	100.00	96.73	99.63	98.05	99.69	0.000994	1.92	52.04	28.50	0.25
Reach-1	13.*	200.00	96.73	100.52	98.68	100.61	0.001241	2.44	82.00	41.50	0.29

Reach-1	13.*	500.00	96.73	101.66	100.01	101.80	0.001338	3.34	260.09	271.70	0.32
Reach-1	13.*	750.00	96.73	102.15	100.87	102.30	0.001385	3.72	416.01	370.05	0.33
Reach-1	13.*	1000.00	96.73	102.49	101.56	102.65	0.001389	3.95	554.06	405.34	0.34
Reach-1	13.*	1500.00	96.73	102.99	102.11	103.15	0.001449	4.35	757.10	405.34	0.35
Reach-1	12.8	10.00	96.47	98.37	96.84	98.37	0.000048	0.36	27.86	19.37	0.05
Reach-1	12.8	20.00	96.47	98.60	97.01	98.60	0.000124	0.62	32.42	20.36	0.09
Reach-1	12.8	30.00	96.47	98.78	97.14	98.79	0.000205	0.83	36.15	21.15	0.11
Reach-1	12.8	40.00	96.47	98.93	97.25	98.94	0.000289	1.02	39.35	21.86	0.13
Reach-1	12.8	50.00	96.47	99.06	97.36	99.08	0.000369	1.18	42.30	22.50	0.15
Reach-1	12.8	60.00	96.47	99.18	97.46	99.21	0.000447	1.33	45.05	23.08	0.17
Reach-1	12.8	70.00	96.47	99.30	97.54	99.33	0.000517	1.46	47.80	23.65	0.18
Reach-1	12.8	80.00	96.47	99.41	97.63	99.45	0.000585	1.59	50.36	24.17	0.19
Reach-1	12.8	90.00	96.47	99.52	97.71	99.57	0.000651	1.69	53.22	25.19	0.21
Reach-1	12.8	100.00	96.47	99.62	97.78	99.67	0.000733	1.79	55.82	26.54	0.22
Reach-1	12.8	200.00	96.47	100.50	98.42	100.59	0.001180	2.37	84.46	44.42	0.28
Reach-1	12.8	500.00	96.47	101.64	99.80	101.78	0.001277	3.25	265.66	274.33	0.31
Reach-1	12.8	750.00	96.47	102.12	100.72	102.27	0.001332	3.63	422.26	372.28	0.33
Reach-1	12.8	1000.00	96.47	102.47	101.48	102.62	0.001343	3.86	560.22	406.00	0.33
Reach-1	12.8	1500.00	96.47	102.97	102.06	103.12	0.001414	4.27	762.73	406.00	0.35
Reach-1	12.6*	10.00	96.78	98.37	97.19	98.37	0.000093	0.44	22.62	19.33	0.07
Reach-1	12.6*	20.00	96.78	98.59	97.34	98.60	0.000221	0.74	27.11	20.49	0.11
Reach-1	12.6*	30.00	96.78	98.77	97.47	98.78	0.000347	0.97	30.82	21.50	0.14
Reach-1	12.6*	40.00	96.78	98.91	97.59	98.94	0.000470	1.18	33.99	22.33	0.17
Reach-1	12.6*	50.00	96.78	99.04	97.69	99.07	0.000583	1.35	36.94	23.08	0.19
Reach-1	12.6*	60.00	96.78	99.16	97.78	99.20	0.000691	1.51	39.69	23.87	0.21
Reach-1	12.6*	70.00	96.78	99.28	97.87	99.32	0.000817	1.65	42.54	25.56	0.22
Reach-1	12.6*	80.00	96.78	99.38	97.95	99.43	0.000935	1.77	45.29	27.09	0.24
Reach-1	12.6*	90.00	96.78	99.50	98.03	99.55	0.001013	1.86	48.50	28.63	0.25
Reach-1	12.6*	100.00	96.78	99.60	98.10	99.65	0.001090	1.95	51.40	29.84	0.26
Reach-1	12.6*	200.00	96.78	100.47	98.71	100.56	0.001241	2.46	81.54	44.70	0.29
Reach-1	12.6*	500.00	96.78	101.60	100.00	101.75	0.001336	3.35	262.18	274.15	0.32
Reach-1	12.6*	750.00	96.78	102.09	100.88	102.24	0.001383	3.73	418.55	372.14	0.34
Reach-1	12.6*	1000.00	96.78	102.44	101.51	102.59	0.001380	3.95	557.29	405.00	0.34
Reach-1	12.6*	1500.00	96.78	102.93	102.06	103.09	0.001447	4.36	758.75	405.00	0.35
Reach-1	12.4*	10.00	97.10	98.36	97.54	98.37	0.000229	0.58	17.17	19.45	0.11
Reach-1	12.4*	20.00	97.10	98.58	97.70	98.59	0.000474	0.93	21.60	20.99	0.16
Reach-1	12.4*	30.00	97.10	98.75	97.82	98.77	0.000684	1.19	25.29	22.23	0.20
Reach-1	12.4*	40.00	97.10	98.89	97.93	98.92	0.000898	1.40	28.48	23.81	0.23
Reach-1	12.4*	50.00	97.10	99.02	98.03	99.06	0.001108	1.58	31.60	25.87	0.25
Reach-1	12.4*	60.00	97.10	99.13	98.11	99.18	0.001267	1.73	34.64	27.37	0.27
Reach-1	12.4*	70.00	97.10	99.24	98.20	99.30	0.001372	1.85	37.79	28.64	0.28
Reach-1	12.4*	80.00	97.10	99.35	98.27	99.41	0.001466	1.96	40.78	29.79	0.30
Reach-1	12.4*	90.00	97.10	99.46	98.35	99.52	0.001495	2.03	44.26	31.07	0.30
Reach-1	12.4*	100.00	97.10	99.56	98.42	99.63	0.001545	2.11	47.36	32.18	0.31
Reach-1	12.4*	200.00	97.10	100.43	99.02	100.54	0.001385	2.59	77.31	41.71	0.31
Reach-1	12.4*	500.00	97.10	101.56	100.05	101.72	0.001466	3.51	253.69	271.06	0.34
Reach-1	12.4*	750.00	97.10	102.05	101.04	102.21	0.001495	3.88	408.94	369.61	0.35
Reach-1	12.4*	1000.00	97.10	102.40	101.55	102.56	0.001467	4.08	548.69	404.00	0.35
Reach-1	12.4*	1500.00	97.10	102.90	102.07	103.06	0.001519	4.47	749.81	404.00	0.36
Reach-1	12.2*	10.00	97.41	98.35	97.87	98.36	0.000854	0.86	11.62	19.94	0.20
Reach-1	12.2*	20.00	97.41	98.55	98.03	98.58	0.001391	1.25	15.97	22.45	0.26
Reach-1	12.2*	30.00	97.41	98.72	98.15	98.75	0.001789	1.51	19.87	25.45	0.30
Reach-1	12.2*	40.00	97.41	98.85	98.25	98.90	0.001993	1.71	23.35	26.79	0.32
Reach-1	12.2*	50.00	97.41	98.97	98.34	99.02	0.002131	1.88	26.65	28.00	0.34
Reach-1	12.2*	60.00	97.41	99.08	98.42	99.14	0.002230	2.01	29.80	29.11	0.35

Reach-1	12.2*	70.00	97.41	99.19	98.50	99.26	0.002255	2.12	33.09	30.25	0.36
Reach-1	12.2*	80.00	97.41	99.29	98.58	99.37	0.002297	2.21	36.20	31.39	0.36
Reach-1	12.2*	90.00	97.41	99.41	98.65	99.49	0.002151	2.26	39.90	31.86	0.36
Reach-1	12.2*	100.00	97.41	99.51	98.72	99.59	0.002086	2.32	43.04	32.03	0.35
Reach-1	12.2*	200.00	97.41	100.39	99.20	100.51	0.001653	2.78	71.90	38.60	0.34
Reach-1	12.2*	500.00	97.41	101.51	100.14	101.69	0.001669	3.71	243.70	266.59	0.36
Reach-1	12.2*	750.00	97.41	102.00	101.15	102.18	0.001655	4.05	398.01	365.47	0.37
Reach-1	12.2*	1000.00	97.41	102.36	101.59	102.53	0.001589	4.22	539.27	403.00	0.37
Reach-1	12.2*	1500.00	97.41	102.86	102.09	103.03	0.001611	4.58	740.92	403.00	0.38
Reach-1	12	10.00	97.72	98.25	98.17	98.31	0.013108	2.00	5.00	18.93	0.69
Reach-1	12	20.00	97.72	98.44	98.32	98.52	0.009240	2.16	9.24	23.90	0.61
Reach-1	12	30.00	97.72	98.61	98.42	98.68	0.006888	2.24	13.37	26.20	0.55
Reach-1	12	40.00	97.72	98.74	98.51	98.83	0.005873	2.35	16.99	27.44	0.53
Reach-1	12	50.00	97.72	98.86	98.58	98.96	0.005268	2.45	20.42	28.63	0.51
Reach-1	12	60.00	97.72	98.98	98.64	99.08	0.004839	2.53	23.72	29.67	0.50
Reach-1	12	70.00	97.72	99.09	98.70	99.20	0.004222	2.57	27.22	29.87	0.47
Reach-1	12	80.00	97.72	99.20	98.76	99.31	0.003898	2.64	30.32	30.05	0.46
Reach-1	12	90.00	97.72	99.32	98.82	99.43	0.003381	2.64	34.11	30.27	0.44
Reach-1	12	100.00	97.72	99.42	98.87	99.54	0.003170	2.69	37.17	30.44	0.43
Reach-1	12	200.00	97.72	100.32	99.29	100.47	0.002164	3.07	65.10	32.00	0.38
Reach-1	12	500.00	97.72	101.45	100.25	101.65	0.002012	3.97	230.10	260.62	0.39
Reach-1	12	750.00	97.72	101.95	101.25	102.14	0.001895	4.25	385.21	361.71	0.39
Reach-1	12	1000.00	97.72	102.32	101.63	102.49	0.001747	4.36	530.24	402.00	0.38
Reach-1	12	1500.00	97.72	102.82	102.19	102.99	0.001719	4.67	733.57	402.00	0.39
Reach-1	11.8*	10.00	97.46	98.08	97.92	98.12	0.006723	1.70	5.87	17.09	0.51
Reach-1	11.8*	20.00	97.46	98.32	98.08	98.38	0.005169	1.91	10.45	20.93	0.48
Reach-1	11.8*	30.00	97.46	98.50	98.20	98.57	0.004727	2.06	14.59	24.50	0.47
Reach-1	11.8*	40.00	97.46	98.65	98.30	98.72	0.004251	2.18	18.36	26.06	0.46
Reach-1	11.8*	50.00	97.46	98.78	98.39	98.86	0.003982	2.29	21.84	27.34	0.45
Reach-1	11.8*	60.00	97.46	98.90	98.47	98.99	0.003800	2.39	25.14	28.50	0.45
Reach-1	11.8*	70.00	97.46	99.03	98.54	99.12	0.003479	2.43	28.83	29.78	0.43
Reach-1	11.8*	80.00	97.46	99.13	98.60	99.23	0.003346	2.49	32.12	30.98	0.43
Reach-1	11.8*	90.00	97.46	99.27	98.66	99.37	0.002845	2.47	36.38	31.26	0.40
Reach-1	11.8*	100.00	97.46	99.38	98.72	99.47	0.002658	2.52	39.69	31.44	0.40
Reach-1	11.8*	200.00	97.46	100.29	99.19	100.42	0.001839	2.89	69.16	33.19	0.35
Reach-1	11.8*	500.00	97.46	101.42	100.11	101.60	0.001818	3.83	235.10	261.42	0.38
Reach-1	11.8*	750.00	97.46	101.91	101.13	102.10	0.001761	4.15	389.56	361.83	0.38
Reach-1	11.8*	1000.00	97.46	102.28	101.55	102.45	0.001650	4.28	534.43	402.66	0.37
Reach-1	11.8*	1500.00	97.46	102.79	102.03	102.96	0.001650	4.62	737.59	402.66	0.38
Reach-1	11.6*	10.00	97.19	98.05	97.64	98.07	0.001265	1.01	9.92	18.04	0.24
Reach-1	11.6*	20.00	97.19	98.28	97.80	98.31	0.001720	1.40	14.33	20.05	0.29
Reach-1	11.6*	30.00	97.19	98.46	97.92	98.50	0.002008	1.66	18.02	21.66	0.32
Reach-1	11.6*	40.00	97.19	98.60	98.03	98.66	0.002342	1.88	21.26	23.85	0.35
Reach-1	11.6*	50.00	97.19	98.73	98.12	98.79	0.002583	2.05	24.44	25.98	0.37
Reach-1	11.6*	60.00	97.19	98.85	98.21	98.92	0.002654	2.18	27.56	27.21	0.38
Reach-1	11.6*	70.00	97.19	98.98	98.29	99.05	0.002563	2.25	31.17	28.57	0.38
Reach-1	11.6*	80.00	97.19	99.08	98.36	99.17	0.002559	2.33	34.33	29.71	0.38
Reach-1	11.6*	90.00	97.19	99.23	98.43	99.31	0.002331	2.33	38.68	31.27	0.37
Reach-1	11.6*	100.00	97.19	99.34	98.50	99.42	0.002272	2.37	42.12	32.36	0.37
Reach-1	11.6*	200.00	97.19	100.27	99.04	100.38	0.001598	2.74	73.03	35.27	0.33
Reach-1	11.6*	500.00	97.19	101.39	99.99	101.57	0.001654	3.69	241.09	263.56	0.36
Reach-1	11.6*	750.00	97.19	101.88	101.01	102.06	0.001639	4.03	395.71	363.63	0.37
Reach-1	11.6*	1000.00	97.19	102.25	101.46	102.42	0.001555	4.18	540.76	403.34	0.36
Reach-1	11.6*	1500.00	97.19	102.76	101.97	102.92	0.001580	4.55	743.63	403.34	0.37
Reach-1	11.4*	10.00	96.93	98.04	97.37	98.05	0.000387	0.70	14.34	18.46	0.14

Reach-1	11.4*	20.00	96.93	98.27	97.53	98.29	0.000716	1.07	18.69	19.96	0.19
Reach-1	11.4*	30.00	96.93	98.44	97.65	98.47	0.000983	1.35	22.24	21.22	0.23
Reach-1	11.4*	40.00	96.93	98.58	97.76	98.62	0.001221	1.58	25.25	22.22	0.26
Reach-1	11.4*	50.00	96.93	98.70	97.86	98.75	0.001455	1.78	28.01	23.49	0.29
Reach-1	11.4*	60.00	96.93	98.81	97.94	98.87	0.001696	1.95	30.77	25.34	0.31
Reach-1	11.4*	70.00	96.93	98.94	98.03	99.01	0.001793	2.05	34.13	27.17	0.32
Reach-1	11.4*	80.00	96.93	99.05	98.10	99.12	0.001881	2.16	37.10	28.37	0.33
Reach-1	11.4*	90.00	96.93	99.19	98.18	99.27	0.001793	2.18	41.32	29.99	0.33
Reach-1	11.4*	100.00	96.93	99.30	98.25	99.38	0.001808	2.24	44.61	31.20	0.33
Reach-1	11.4*	200.00	96.93	100.24	98.85	100.35	0.001425	2.61	76.59	39.75	0.31
Reach-1	11.4*	500.00	96.93	101.37	99.88	101.53	0.001513	3.55	248.85	266.57	0.34
Reach-1	11.4*	750.00	96.93	101.86	100.87	102.03	0.001527	3.91	403.92	365.52	0.35
Reach-1	11.4*	1000.00	96.93	102.23	101.37	102.39	0.001466	4.08	548.92	404.00	0.35
Reach-1	11.4*	1500.00	96.93	102.73	101.90	102.89	0.001512	4.47	751.23	404.00	0.36
Reach-1	11.2*	10.00	96.66	98.04	97.08	98.04	0.000160	0.53	18.92	18.79	0.09
Reach-1	11.2*	20.00	96.66	98.26	97.23	98.28	0.000353	0.86	23.26	20.02	0.14
Reach-1	11.2*	30.00	96.66	98.43	97.36	98.45	0.000535	1.12	26.74	21.03	0.18
Reach-1	11.2*	40.00	96.66	98.57	97.47	98.60	0.000712	1.35	29.65	21.87	0.20
Reach-1	11.2*	50.00	96.66	98.69	97.58	98.73	0.000877	1.55	32.29	22.60	0.23
Reach-1	11.2*	60.00	96.66	98.80	97.66	98.84	0.001025	1.72	34.81	23.28	0.25
Reach-1	11.2*	70.00	96.66	98.92	97.75	98.98	0.001164	1.85	37.80	24.99	0.27
Reach-1	11.2*	80.00	96.66	99.03	97.83	99.09	0.001313	1.98	40.47	26.58	0.28
Reach-1	11.2*	90.00	96.66	99.17	97.91	99.23	0.001334	2.02	44.45	28.49	0.29
Reach-1	11.2*	100.00	96.66	99.28	97.98	99.35	0.001396	2.10	47.54	29.77	0.29
Reach-1	11.2*	200.00	96.66	100.22	98.59	100.32	0.001299	2.51	79.84	42.53	0.30
Reach-1	11.2*	500.00	96.66	101.35	99.79	101.50	0.001410	3.44	255.16	269.55	0.33
Reach-1	11.2*	750.00	96.66	101.83	100.71	102.00	0.001442	3.81	411.04	368.30	0.34
Reach-1	11.2*	1000.00	96.66	102.20	101.29	102.36	0.001395	3.98	556.37	404.66	0.34
Reach-1	11.2*	1500.00	96.66	102.70	101.83	102.86	0.001457	4.38	758.08	404.66	0.36
Reach-1	11.*	10.00	96.39	98.04	96.79	98.04	0.000081	0.43	23.49	19.12	0.07
Reach-1	11.*	20.00	96.39	98.26	96.95	98.27	0.000200	0.72	27.85	20.19	0.11
Reach-1	11.*	30.00	96.39	98.43	97.08	98.44	0.000322	0.96	31.31	21.03	0.14
Reach-1	11.*	40.00	96.39	98.56	97.19	98.58	0.000449	1.17	34.18	21.76	0.16
Reach-1	11.*	50.00	96.39	98.68	97.29	98.71	0.000573	1.36	36.77	22.39	0.19
Reach-1	11.*	60.00	96.39	98.79	97.40	98.82	0.000690	1.53	39.21	22.98	0.21
Reach-1	11.*	70.00	96.39	98.91	97.48	98.95	0.000773	1.66	42.07	23.64	0.22
Reach-1	11.*	80.00	96.39	99.01	97.56	99.06	0.000881	1.80	44.51	24.56	0.24
Reach-1	11.*	90.00	96.39	99.15	97.64	99.21	0.000951	1.87	48.14	26.56	0.24
Reach-1	11.*	100.00	96.39	99.26	97.71	99.32	0.001040	1.96	50.99	28.03	0.26
Reach-1	11.*	200.00	96.39	100.20	98.33	100.29	0.001205	2.42	82.83	45.54	0.29
Reach-1	11.*	500.00	96.39	101.32	99.67	101.47	0.001327	3.33	261.49	272.76	0.32
Reach-1	11.*	750.00	96.39	101.81	100.54	101.96	0.001371	3.71	418.37	371.36	0.33
Reach-1	11.*	1000.00	96.39	102.18	101.21	102.33	0.001333	3.88	564.16	405.34	0.33
Reach-1	11.*	1500.00	96.39	102.67	101.78	102.83	0.001409	4.30	765.22	405.34	0.35
Reach-1	10.8	10.00	96.13	98.04	96.51	98.04	0.000047	0.36	28.04	19.41	0.05
Reach-1	10.8	20.00	96.13	98.26	96.67	98.27	0.000124	0.62	32.43	20.37	0.09
Reach-1	10.8	30.00	96.13	98.43	96.80	98.44	0.000210	0.84	35.89	21.09	0.11
Reach-1	10.8	40.00	96.13	98.56	96.91	98.58	0.000302	1.03	38.73	21.73	0.14
Reach-1	10.8	50.00	96.13	98.67	97.02	98.70	0.000395	1.21	41.27	22.28	0.16
Reach-1	10.8	60.00	96.13	98.78	97.12	98.81	0.000487	1.37	43.68	22.80	0.17
Reach-1	10.8	70.00	96.13	98.90	97.20	98.94	0.000558	1.51	46.49	23.38	0.19
Reach-1	10.8	80.00	96.13	99.00	97.29	99.05	0.000636	1.64	48.85	23.86	0.20
Reach-1	10.8	90.00	96.13	99.14	97.37	99.19	0.000673	1.72	52.27	24.67	0.21
Reach-1	10.8	100.00	96.13	99.25	97.45	99.30	0.000758	1.82	54.87	26.05	0.22
Reach-1	10.8	200.00	96.13	100.18	98.08	100.27	0.001144	2.35	85.42	48.61	0.28
Reach-1	10.8	500.00	96.13	101.30	99.46	101.44	0.001266	3.24	267.17	275.44	0.31

Reach-1	10.8	750.00	96.13	101.79	100.38	101.94	0.001318	3.62	424.79	373.65	0.32
Reach-1	10.8	1000.00	96.13	102.16	101.14	102.30	0.001286	3.80	570.87	406.00	0.33
Reach-1	10.8	1500.00	96.13	102.65	101.72	102.80	0.001373	4.22	771.25	406.00	0.34
Reach-1	10.6*	10.00	96.45	98.04	96.86	98.04	0.000093	0.44	22.66	19.36	0.07
Reach-1	10.6*	20.00	96.45	98.25	97.01	98.26	0.000224	0.74	26.99	20.48	0.11
Reach-1	10.6*	30.00	96.45	98.42	97.14	98.43	0.000361	0.99	30.40	21.40	0.15
Reach-1	10.6*	40.00	96.45	98.54	97.25	98.57	0.000502	1.20	33.20	22.13	0.17
Reach-1	10.6*	50.00	96.45	98.66	97.35	98.69	0.000640	1.40	35.71	22.77	0.20
Reach-1	10.6*	60.00	96.45	98.76	97.45	98.80	0.000771	1.58	38.07	23.35	0.22
Reach-1	10.6*	70.00	96.45	98.88	97.54	98.92	0.000885	1.71	40.90	24.58	0.23
Reach-1	10.6*	80.00	96.45	98.98	97.62	99.03	0.001028	1.85	43.36	26.05	0.25
Reach-1	10.6*	90.00	96.45	99.12	97.69	99.17	0.001085	1.91	47.18	28.12	0.26
Reach-1	10.6*	100.00	96.45	99.22	97.77	99.28	0.001163	2.00	50.08	29.36	0.27
Reach-1	10.6*	200.00	96.45	100.15	98.38	100.24	0.001213	2.44	82.21	46.92	0.29
Reach-1	10.6*	500.00	96.45	101.27	99.67	101.41	0.001346	3.36	260.42	272.72	0.32
Reach-1	10.6*	750.00	96.45	101.75	100.54	101.91	0.001393	3.74	416.40	370.87	0.34
Reach-1	10.6*	1000.00	96.45	102.12	101.17	102.27	0.001345	3.91	563.18	405.00	0.34
Reach-1	10.6*	1500.00	96.45	102.61	101.73	102.77	0.001426	4.34	762.63	405.00	0.35
Reach-1	10.4*	10.00	96.76	98.03	97.20	98.04	0.000227	0.58	17.21	19.44	0.11
Reach-1	10.4*	20.00	96.76	98.24	97.36	98.26	0.000483	0.93	21.46	20.92	0.16
Reach-1	10.4*	30.00	96.76	98.40	97.48	98.42	0.000720	1.21	24.82	22.06	0.20
Reach-1	10.4*	40.00	96.76	98.52	97.59	98.55	0.000963	1.45	27.57	23.13	0.23
Reach-1	10.4*	50.00	96.76	98.63	97.69	98.67	0.001236	1.66	30.10	24.86	0.27
Reach-1	10.4*	60.00	96.76	98.72	97.78	98.78	0.001482	1.84	32.60	26.46	0.29
Reach-1	10.4*	70.00	96.76	98.84	97.86	98.90	0.001585	1.96	35.76	27.80	0.30
Reach-1	10.4*	80.00	96.76	98.93	97.94	99.00	0.001715	2.08	38.41	28.85	0.32
Reach-1	10.4*	90.00	96.76	99.08	98.01	99.14	0.001648	2.11	42.64	30.46	0.31
Reach-1	10.4*	100.00	96.76	99.18	98.08	99.25	0.001691	2.19	45.74	31.58	0.32
Reach-1	10.4*	200.00	96.76	100.11	98.69	100.22	0.001357	2.58	77.86	44.01	0.30
Reach-1	10.4*	500.00	96.76	101.22	99.72	101.38	0.001485	3.53	251.18	268.75	0.34
Reach-1	10.4*	750.00	96.76	101.71	100.70	101.88	0.001513	3.90	405.52	367.18	0.35
Reach-1	10.4*	1000.00	96.76	102.08	101.21	102.24	0.001435	4.04	553.64	404.00	0.35
Reach-1	10.4*	1500.00	96.76	102.58	101.74	102.74	0.001503	4.46	752.65	404.00	0.36
Reach-1	10.2*	10.00	97.08	98.02	97.54	98.03	0.000873	0.87	11.53	19.92	0.20
Reach-1	10.2*	20.00	97.08	98.21	97.70	98.24	0.001463	1.28	15.66	22.22	0.27
Reach-1	10.2*	30.00	97.08	98.36	97.82	98.40	0.002006	1.57	19.11	25.15	0.32
Reach-1	10.2*	40.00	97.08	98.47	97.93	98.52	0.002368	1.82	22.00	26.30	0.35
Reach-1	10.2*	50.00	97.08	98.57	98.01	98.63	0.002691	2.03	24.57	27.26	0.38
Reach-1	10.2*	60.00	97.08	98.66	98.10	98.73	0.002942	2.22	27.05	28.16	0.40
Reach-1	10.2*	70.00	97.08	98.77	98.17	98.85	0.002872	2.30	30.39	29.33	0.40
Reach-1	10.2*	80.00	97.08	98.86	98.25	98.95	0.002948	2.42	33.09	30.26	0.41
Reach-1	10.2*	90.00	97.08	99.01	98.32	99.10	0.002559	2.38	37.80	31.74	0.38
Reach-1	10.2*	100.00	97.08	99.12	98.39	99.21	0.002431	2.44	41.02	31.92	0.38
Reach-1	10.2*	200.00	97.08	100.07	98.87	100.19	0.001628	2.77	72.30	41.00	0.33
Reach-1	10.2*	500.00	97.08	101.17	99.81	101.35	0.001699	3.73	241.16	264.70	0.36
Reach-1	10.2*	750.00	97.08	101.66	100.83	101.84	0.001679	4.07	394.97	363.82	0.37
Reach-1	10.2*	1000.00	97.08	102.05	101.26	102.21	0.001544	4.17	545.94	403.00	0.36
Reach-1	10.2*	1500.00	97.08	102.54	101.75	102.71	0.001588	4.56	745.09	403.00	0.37
Reach-1	10	10.00	97.40	97.85	97.85	97.97	0.030277	2.74	3.65	16.18	1.01
Reach-1	10	20.00	97.40	98.00	98.00	98.15	0.026625	3.10	6.45	21.50	1.00
Reach-1	10	30.00	97.40	98.10	98.10	98.28	0.024840	3.45	8.70	23.45	1.00
Reach-1	10	40.00	97.40	98.20	98.19	98.40	0.021534	3.59	11.14	25.40	0.96
Reach-1	10	50.00	97.40	98.30	98.26	98.51	0.017630	3.64	13.73	26.32	0.89
Reach-1	10	60.00	97.40	98.40	98.32	98.61	0.014700	3.66	16.40	27.24	0.83
Reach-1	10	70.00	97.40	98.60	98.38	98.76	0.008229	3.18	22.04	29.22	0.64

Reach-1	10	80.00	97.40	98.70	98.44	98.86	0.007256	3.20	25.00	29.74	0.61
Reach-1	10	90.00	97.40	98.90	98.50	99.03	0.004600	2.90	30.99	30.09	0.50
Reach-1	10	100.00	97.40	99.01	98.55	99.14	0.004097	2.91	34.31	30.28	0.48
Reach-1	10	200.00	97.40	100.00	98.98	100.15	0.002160	3.07	65.14	32.00	0.38
Reach-1	10	500.00	97.40	101.10	99.92	101.31	0.002112	4.05	223.02	255.06	0.40
Reach-1	10	750.00	97.40	101.60	100.93	101.80	0.001981	4.33	375.89	356.44	0.40
Reach-1	10	1000.00	97.40	102.00	101.31	102.17	0.001737	4.34	531.51	402.00	0.38
Reach-1	10	1500.00	97.40	102.50	101.87	102.67	0.001726	4.68	732.51	402.00	0.39

Design Channel: Bankfull Discharge = 200 cfs; Slope = 0.0026 ft/ft

Profile Output Table - Standard Table 1
HEC-RAS Plan: q200s26i River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 691
Plans = 1
Profiles = 15

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	20	10.00	100.10	100.63	100.54	100.68	0.011049	1.87	5.36	19.79	0.63
Reach-1	20	20.00	100.10	100.78	100.68	100.86	0.011503	2.35	8.51	22.91	0.68
Reach-1	20	30.00	100.10	100.91	100.78	101.01	0.009812	2.57	11.69	24.42	0.65
Reach-1	20	40.00	100.10	101.03	100.87	101.15	0.008553	2.71	14.75	25.55	0.63
Reach-1	20	50.00	100.10	101.15	100.94	101.27	0.007626	2.80	17.88	27.09	0.61
Reach-1	20	60.00	100.10	101.27	101.00	101.39	0.006859	2.85	21.08	28.68	0.59
Reach-1	20	70.00	100.10	101.37	101.07	101.50	0.006031	2.90	24.13	28.87	0.56
Reach-1	20	80.00	100.10	101.48	101.13	101.61	0.005413	2.95	27.10	29.05	0.54
Reach-1	20	90.00	100.10	101.57	101.20	101.71	0.005046	3.02	29.81	29.21	0.53
Reach-1	20	100.00	100.10	101.66	101.25	101.81	0.004752	3.08	32.44	29.36	0.52
Reach-1	20	200.00	100.10	102.39	101.68	102.60	0.003708	3.68	54.32	30.63	0.49
Reach-1	20	500.00	100.10	103.53	102.66	103.83	0.003238	4.75	177.29	219.49	0.49
Reach-1	20	750.00	100.10	104.01	103.62	104.30	0.003012	5.08	307.26	317.62	0.49
Reach-1	20	1000.00	100.10	104.36	103.96	104.64	0.002926	5.34	428.18	387.20	0.49
Reach-1	20	1500.00	100.10	104.83	104.49	105.09	0.002813	5.66	615.79	401.00	0.49
Reach-1	19.8*	10.00	99.82	100.32	100.27	100.41	0.017613	2.40	4.16	14.91	0.80
Reach-1	19.8*	20.00	99.82	100.55	100.42	100.64	0.010482	2.48	8.07	18.69	0.66
Reach-1	19.8*	30.00	99.82	100.73	100.54	100.83	0.008366	2.55	11.75	21.89	0.61
Reach-1	19.8*	40.00	99.82	100.89	100.65	100.99	0.006856	2.61	15.31	23.68	0.57
Reach-1	19.8*	50.00	99.82	101.03	100.74	101.14	0.005914	2.67	18.73	25.07	0.54
Reach-1	19.8*	60.00	99.82	101.15	100.81	101.27	0.005334	2.73	21.99	26.32	0.53
Reach-1	19.8*	70.00	99.82	101.27	100.88	101.39	0.004973	2.78	25.15	27.69	0.51
Reach-1	19.8*	80.00	99.82	101.38	100.95	101.51	0.004761	2.82	28.34	29.54	0.51
Reach-1	19.8*	90.00	99.82	101.48	101.01	101.61	0.004389	2.87	31.39	29.99	0.49
Reach-1	19.8*	100.00	99.82	101.58	101.07	101.71	0.004072	2.91	34.31	30.16	0.48
Reach-1	19.8*	200.00	99.82	102.34	101.55	102.52	0.003160	3.47	57.56	31.46	0.45
Reach-1	19.8*	500.00	99.82	103.48	102.50	103.76	0.002909	4.57	181.85	220.51	0.47
Reach-1	19.8*	750.00	99.82	103.96	103.50	104.24	0.002802	4.96	310.32	317.30	0.47
Reach-1	19.8*	1000.00	99.82	104.30	103.87	104.58	0.002777	5.26	429.61	386.03	0.48
Reach-1	19.8*	1500.00	99.82	104.76	104.42	105.03	0.002739	5.64	615.06	401.50	0.48
Reach-1	19.6*	10.00	99.53	100.24	99.98	100.27	0.002932	1.36	7.34	15.98	0.35
Reach-1	19.6*	20.00	99.53	100.47	100.13	100.52	0.003319	1.78	11.26	18.01	0.40
Reach-1	19.6*	30.00	99.53	100.65	100.26	100.72	0.003494	2.05	14.67	19.67	0.42
Reach-1	19.6*	40.00	99.53	100.81	100.37	100.89	0.003620	2.24	17.85	21.37	0.43
Reach-1	19.6*	50.00	99.53	100.95	100.46	101.04	0.003728	2.38	21.05	23.57	0.44
Reach-1	19.6*	60.00	99.53	101.08	100.55	101.18	0.003638	2.48	24.21	24.96	0.44
Reach-1	19.6*	70.00	99.53	101.20	100.63	101.30	0.003567	2.57	27.26	26.22	0.44
Reach-1	19.6*	80.00	99.53	101.31	100.71	101.42	0.003492	2.64	30.27	27.41	0.44
Reach-1	19.6*	90.00	99.53	101.42	100.79	101.53	0.003462	2.71	33.19	28.70	0.44

Reach-1	19.6*	100.00	99.53	101.52	100.86	101.63	0.003460	2.77	36.12	30.26	0.45
Reach-1	19.6*	200.00	99.53	102.29	101.40	102.46	0.002762	3.30	60.57	32.29	0.42
Reach-1	19.6*	500.00	99.53	103.44	102.37	103.70	0.002634	4.40	187.59	223.28	0.45
Reach-1	19.6*	750.00	99.53	103.91	103.39	104.18	0.002607	4.82	315.68	319.14	0.46
Reach-1	19.6*	1000.00	99.53	104.25	103.78	104.52	0.002626	5.15	434.27	387.28	0.46
Reach-1	19.6*	1500.00	99.53	104.71	104.27	104.97	0.002646	5.57	617.77	402.00	0.48
Reach-1	19.4*	10.00	99.24	100.23	99.68	100.24	0.000690	0.87	11.56	16.64	0.18
Reach-1	19.4*	20.00	99.24	100.45	99.83	100.48	0.001185	1.30	15.42	18.06	0.25
Reach-1	19.4*	30.00	99.24	100.63	99.96	100.67	0.001540	1.61	18.69	19.26	0.29
Reach-1	19.4*	40.00	99.24	100.78	100.08	100.83	0.001804	1.85	21.68	20.36	0.32
Reach-1	19.4*	50.00	99.24	100.91	100.18	100.98	0.002000	2.04	24.52	21.38	0.34
Reach-1	19.4*	60.00	99.24	101.04	100.27	101.11	0.002270	2.20	27.33	23.46	0.36
Reach-1	19.4*	70.00	99.24	101.15	100.36	101.24	0.002407	2.32	30.16	24.85	0.37
Reach-1	19.4*	80.00	99.24	101.27	100.44	101.36	0.002496	2.43	32.97	26.11	0.38
Reach-1	19.4*	90.00	99.24	101.37	100.52	101.47	0.002570	2.52	35.70	27.28	0.39
Reach-1	19.4*	100.00	99.24	101.47	100.59	101.57	0.002622	2.60	38.42	28.39	0.39
Reach-1	19.4*	200.00	99.24	102.25	101.21	102.40	0.002480	3.16	63.27	33.10	0.40
Reach-1	19.4*	500.00	99.24	103.40	102.25	103.64	0.002391	4.22	195.55	227.80	0.43
Reach-1	19.4*	750.00	99.24	103.87	103.27	104.12	0.002414	4.67	324.25	322.18	0.44
Reach-1	19.4*	1000.00	99.24	104.20	103.68	104.46	0.002470	5.01	442.21	389.07	0.45
Reach-1	19.4*	1500.00	99.24	104.66	104.17	104.92	0.002540	5.47	623.67	402.50	0.47
Reach-1	19.2*	10.00	98.96	100.22	99.38	100.23	0.000254	0.63	15.86	17.08	0.12
Reach-1	19.2*	20.00	98.96	100.44	99.55	100.46	0.000539	1.01	19.71	18.21	0.17
Reach-1	19.2*	30.00	98.96	100.61	99.67	100.64	0.000791	1.31	22.91	19.17	0.21
Reach-1	19.2*	40.00	98.96	100.76	99.79	100.80	0.001009	1.55	25.80	20.07	0.24
Reach-1	19.2*	50.00	98.96	100.89	99.90	100.94	0.001192	1.75	28.53	20.88	0.26
Reach-1	19.2*	60.00	98.96	101.02	99.99	101.07	0.001350	1.93	31.12	21.62	0.28
Reach-1	19.2*	70.00	98.96	101.13	100.08	101.20	0.001552	2.08	33.62	23.13	0.30
Reach-1	19.2*	80.00	98.96	101.23	100.16	101.31	0.001728	2.21	36.18	24.66	0.32
Reach-1	19.2*	90.00	98.96	101.33	100.24	101.42	0.001862	2.33	38.69	25.84	0.34
Reach-1	19.2*	100.00	98.96	101.43	100.33	101.52	0.001973	2.43	41.21	26.98	0.35
Reach-1	19.2*	200.00	98.96	102.21	100.95	102.35	0.002285	3.05	65.59	33.86	0.39
Reach-1	19.2*	500.00	98.96	103.37	102.15	103.59	0.002222	4.08	202.11	232.02	0.41
Reach-1	19.2*	750.00	98.96	103.83	103.16	104.07	0.002274	4.53	331.72	325.90	0.42
Reach-1	19.2*	1000.00	98.96	104.16	103.60	104.41	0.002353	4.89	449.59	392.23	0.44
Reach-1	19.2*	1500.00	98.96	104.61	104.13	104.86	0.002455	5.38	629.36	403.00	0.46
Reach-1	19.*	10.00	98.68	100.22	99.08	100.23	0.000119	0.50	20.15	17.35	0.08
Reach-1	19.*	20.00	98.68	100.44	99.25	100.45	0.000289	0.83	24.00	18.32	0.13
Reach-1	19.*	30.00	98.68	100.61	99.38	100.63	0.000457	1.10	27.16	19.12	0.16
Reach-1	19.*	40.00	98.68	100.75	99.50	100.78	0.000618	1.33	29.99	19.91	0.19
Reach-1	19.*	50.00	98.68	100.88	99.61	100.92	0.000765	1.53	32.65	20.62	0.21
Reach-1	19.*	60.00	98.68	101.00	99.71	101.05	0.000900	1.71	35.15	21.27	0.23
Reach-1	19.*	70.00	98.68	101.11	99.81	101.17	0.001024	1.87	37.52	21.87	0.25
Reach-1	19.*	80.00	98.68	101.22	99.89	101.28	0.001168	2.01	39.84	22.95	0.27
Reach-1	19.*	90.00	98.68	101.31	99.97	101.38	0.001326	2.14	42.11	24.34	0.29
Reach-1	19.*	100.00	98.68	101.40	100.05	101.48	0.001460	2.25	44.42	25.56	0.30
Reach-1	19.*	200.00	98.68	102.17	100.70	102.31	0.002134	2.96	67.67	34.49	0.37
Reach-1	19.*	500.00	98.68	103.34	102.05	103.54	0.002086	3.95	208.90	236.66	0.40
Reach-1	19.*	750.00	98.68	103.80	103.06	104.02	0.002155	4.40	339.81	330.16	0.41
Reach-1	19.*	1000.00	98.68	104.12	103.51	104.36	0.002252	4.77	457.63	395.85	0.43
Reach-1	19.*	1500.00	98.68	104.56	104.03	104.81	0.002376	5.27	635.95	403.50	0.45
Reach-1	18.8	10.00	98.39	100.22	98.79	100.22	0.000066	0.41	24.41	17.59	0.06
Reach-1	18.8	20.00	98.39	100.44	98.95	100.44	0.000173	0.71	28.28	18.46	0.10
Reach-1	18.8	30.00	98.39	100.60	99.09	100.62	0.000288	0.95	31.43	19.14	0.13
Reach-1	18.8	40.00	98.39	100.75	99.21	100.77	0.000406	1.17	34.22	19.84	0.16

Reach-1	18.8	50.00	98.39	100.88	99.32	100.90	0.000519	1.36	36.84	20.46	0.18
Reach-1	18.8	60.00	98.39	100.99	99.42	101.03	0.000627	1.53	39.28	21.03	0.20
Reach-1	18.8	70.00	98.39	101.10	99.52	101.15	0.000730	1.68	41.59	21.55	0.21
Reach-1	18.8	80.00	98.39	101.20	99.61	101.26	0.000827	1.83	43.81	22.05	0.23
Reach-1	18.8	90.00	98.39	101.30	99.69	101.36	0.000926	1.96	45.91	22.57	0.24
Reach-1	18.8	100.00	98.39	101.39	99.77	101.46	0.001055	2.08	47.99	23.79	0.26
Reach-1	18.8	200.00	98.39	102.13	100.43	102.26	0.001939	2.88	69.50	33.89	0.35
Reach-1	18.8	500.00	98.39	103.30	101.89	103.50	0.001985	3.83	215.25	240.91	0.38
Reach-1	18.8	750.00	98.39	103.76	102.95	103.98	0.002064	4.29	347.30	333.84	0.40
Reach-1	18.8	1000.00	98.39	104.08	103.44	104.31	0.002177	4.66	464.66	398.64	0.42
Reach-1	18.8	1500.00	98.39	104.52	103.95	104.76	0.002318	5.17	641.58	404.00	0.44
Reach-1	18.6*	10.00	98.69	100.22	99.10	100.22	0.000122	0.49	20.22	17.85	0.08
Reach-1	18.6*	20.00	98.69	100.43	99.26	100.44	0.000295	0.83	24.08	18.88	0.13
Reach-1	18.6*	30.00	98.69	100.59	99.40	100.61	0.000471	1.10	27.22	19.80	0.17
Reach-1	18.6*	40.00	98.69	100.73	99.52	100.76	0.000638	1.33	30.03	20.59	0.19
Reach-1	18.6*	50.00	98.69	100.85	99.63	100.89	0.000790	1.53	32.65	21.30	0.22
Reach-1	18.6*	60.00	98.69	100.97	99.72	101.01	0.000931	1.71	35.12	21.94	0.24
Reach-1	18.6*	70.00	98.69	101.07	99.81	101.13	0.001115	1.87	37.49	23.49	0.26
Reach-1	18.6*	80.00	98.69	101.17	99.90	101.23	0.001278	2.01	39.89	24.89	0.28
Reach-1	18.6*	90.00	98.69	101.26	99.98	101.33	0.001419	2.13	42.22	26.01	0.29
Reach-1	18.6*	100.00	98.69	101.35	100.05	101.43	0.001546	2.25	44.54	27.08	0.31
Reach-1	18.6*	200.00	98.69	102.09	100.69	102.22	0.002110	2.96	67.63	34.28	0.37
Reach-1	18.6*	500.00	98.69	103.25	101.97	103.46	0.002059	3.95	211.08	239.06	0.39
Reach-1	18.6*	750.00	98.69	103.70	102.98	103.93	0.002157	4.43	340.33	330.90	0.41
Reach-1	18.6*	1000.00	98.69	104.03	103.43	104.26	0.002252	4.79	458.43	396.64	0.43
Reach-1	18.6*	1500.00	98.69	104.47	103.93	104.71	0.002388	5.30	635.05	403.25	0.45
Reach-1	18.4*	10.00	98.99	100.21	99.42	100.22	0.000279	0.63	15.76	18.19	0.12
Reach-1	18.4*	20.00	98.99	100.41	99.58	100.43	0.000602	1.02	19.57	19.61	0.18
Reach-1	18.4*	30.00	98.99	100.57	99.71	100.60	0.000893	1.32	22.70	20.75	0.22
Reach-1	18.4*	40.00	98.99	100.70	99.82	100.74	0.001178	1.57	25.51	22.18	0.26
Reach-1	18.4*	50.00	98.99	100.82	99.93	100.87	0.001451	1.77	28.29	24.01	0.29
Reach-1	18.4*	60.00	98.99	100.93	100.02	100.99	0.001650	1.94	30.99	25.26	0.31
Reach-1	18.4*	70.00	98.99	101.03	100.10	101.10	0.001825	2.08	33.58	26.40	0.33
Reach-1	18.4*	80.00	98.99	101.13	100.18	101.20	0.001968	2.21	36.15	27.49	0.34
Reach-1	18.4*	90.00	98.99	101.21	100.26	101.30	0.002096	2.33	38.63	28.50	0.35
Reach-1	18.4*	100.00	98.99	101.30	100.33	101.39	0.002214	2.43	41.10	29.59	0.36
Reach-1	18.4*	200.00	98.99	102.03	100.95	102.18	0.002335	3.10	64.51	33.18	0.39
Reach-1	18.4*	500.00	98.99	103.19	101.99	103.41	0.002217	4.10	205.93	236.86	0.41
Reach-1	18.4*	750.00	98.99	103.64	103.01	103.88	0.002299	4.58	333.81	328.15	0.43
Reach-1	18.4*	1000.00	98.99	103.97	103.43	104.22	0.002363	4.92	453.03	394.67	0.44
Reach-1	18.4*	1500.00	98.99	104.42	103.91	104.67	0.002461	5.40	631.62	402.50	0.46
Reach-1	18.2*	10.00	99.28	100.20	99.73	100.21	0.000942	0.90	11.11	19.18	0.21
Reach-1	18.2*	20.00	99.28	100.38	99.89	100.41	0.001681	1.34	14.88	21.68	0.29
Reach-1	18.2*	30.00	99.28	100.53	100.01	100.57	0.002191	1.65	18.16	23.66	0.33
Reach-1	18.2*	40.00	99.28	100.65	100.12	100.70	0.002517	1.89	21.15	24.91	0.36
Reach-1	18.2*	50.00	99.28	100.76	100.21	100.83	0.002737	2.08	24.02	26.05	0.38
Reach-1	18.2*	60.00	99.28	100.87	100.29	100.94	0.002887	2.24	26.81	27.12	0.40
Reach-1	18.2*	70.00	99.28	100.96	100.38	101.05	0.003045	2.38	29.46	28.35	0.41
Reach-1	18.2*	80.00	99.28	101.05	100.46	101.15	0.003183	2.49	32.16	29.85	0.42
Reach-1	18.2*	90.00	99.28	101.14	100.52	101.25	0.003192	2.59	34.81	30.51	0.43
Reach-1	18.2*	100.00	99.28	101.23	100.58	101.34	0.003135	2.67	37.39	30.66	0.43
Reach-1	18.2*	200.00	99.28	101.95	101.09	102.12	0.002798	3.33	60.07	31.94	0.43
Reach-1	18.2*	500.00	99.28	103.11	102.04	103.36	0.002564	4.36	194.51	230.58	0.44
Reach-1	18.2*	750.00	99.28	103.57	103.05	103.83	0.002574	4.80	321.94	323.69	0.45
Reach-1	18.2*	1000.00	99.28	103.91	103.43	104.17	0.002576	5.11	442.83	392.09	0.46
Reach-1	18.2*	1500.00	99.28	104.36	103.89	104.62	0.002598	5.53	625.03	401.75	0.47

Reach-1	18	10.00	99.58	100.10	100.02	100.16	0.012750	1.96	5.10	19.51	0.67
Reach-1	18	20.00	99.58	100.22	100.16	100.33	0.015008	2.58	7.76	22.20	0.77
Reach-1	18	30.00	99.58	100.35	100.26	100.47	0.012781	2.80	10.73	24.05	0.74
Reach-1	18	40.00	99.58	100.48	100.35	100.61	0.010484	2.90	13.80	25.20	0.69
Reach-1	18	50.00	99.58	100.59	100.42	100.73	0.008978	2.97	16.85	26.41	0.65
Reach-1	18	60.00	99.58	100.71	100.48	100.85	0.008171	3.01	19.91	28.38	0.63
Reach-1	18	70.00	99.58	100.81	100.55	100.95	0.007154	3.06	22.88	28.79	0.60
Reach-1	18	80.00	99.58	100.91	100.61	101.06	0.006400	3.11	25.73	28.96	0.58
Reach-1	18	90.00	99.58	101.00	100.68	101.16	0.005883	3.17	28.42	29.12	0.57
Reach-1	18	100.00	99.58	101.09	100.73	101.25	0.005476	3.22	31.03	29.28	0.55
Reach-1	18	200.00	99.58	101.83	101.16	102.05	0.003930	3.75	53.33	30.57	0.50
Reach-1	18	500.00	99.58	102.99	102.14	103.30	0.003380	4.83	172.19	214.72	0.50
Reach-1	18	750.00	99.58	103.48	103.10	103.77	0.003102	5.14	302.09	314.30	0.49
Reach-1	18	1000.00	99.58	103.82	103.44	104.11	0.002994	5.39	423.00	384.48	0.49
Reach-1	18	1500.00	99.58	104.30	103.97	104.57	0.002840	5.69	613.49	401.00	0.49
Reach-1	17.8*	10.00	99.29	99.77	99.73	99.85	0.017895	2.32	4.31	16.44	0.80
Reach-1	17.8*	20.00	99.29	100.00	99.87	100.08	0.009791	2.39	8.36	19.40	0.64
Reach-1	17.8*	30.00	99.29	100.17	99.98	100.27	0.007550	2.49	12.03	21.54	0.59
Reach-1	17.8*	40.00	99.29	100.33	100.08	100.43	0.006594	2.56	15.60	24.20	0.56
Reach-1	17.8*	50.00	99.29	100.47	100.16	100.58	0.005821	2.60	19.22	26.53	0.54
Reach-1	17.8*	60.00	99.29	100.60	100.24	100.71	0.005061	2.65	22.68	27.47	0.51
Reach-1	17.8*	70.00	99.29	100.72	100.32	100.83	0.004586	2.70	25.96	28.33	0.50
Reach-1	17.8*	80.00	99.29	100.83	100.39	100.94	0.004259	2.75	29.07	29.09	0.49
Reach-1	17.8*	90.00	99.29	100.93	100.45	101.05	0.003968	2.81	32.01	29.32	0.47
Reach-1	17.8*	100.00	99.29	101.02	100.51	101.15	0.003751	2.87	34.82	29.54	0.47
Reach-1	17.8*	200.00	99.29	101.79	100.97	101.97	0.003008	3.44	58.17	31.29	0.44
Reach-1	17.8*	500.00	99.29	102.94	101.93	103.23	0.002858	4.57	179.50	217.07	0.47
Reach-1	17.8*	750.00	99.29	103.42	102.96	103.71	0.002778	4.98	306.89	314.23	0.47
Reach-1	17.8*	1000.00	99.29	103.76	103.34	104.05	0.002767	5.29	425.38	383.08	0.48
Reach-1	17.8*	1500.00	99.29	104.23	103.88	104.51	0.002732	5.68	612.09	401.50	0.48
Reach-1	17.6*	10.00	99.01	99.71	99.43	99.73	0.002352	1.22	8.17	17.70	0.32
Reach-1	17.6*	20.00	99.01	99.94	99.58	99.98	0.002692	1.62	12.36	19.46	0.36
Reach-1	17.6*	30.00	99.01	100.12	99.69	100.17	0.002833	1.87	16.00	20.95	0.38
Reach-1	17.6*	40.00	99.01	100.27	99.79	100.34	0.002903	2.07	19.36	22.28	0.39
Reach-1	17.6*	50.00	99.01	100.41	99.89	100.49	0.003048	2.21	22.59	24.33	0.40
Reach-1	17.6*	60.00	99.01	100.54	99.96	100.62	0.003119	2.32	25.88	26.46	0.41
Reach-1	17.6*	70.00	99.01	100.66	100.05	100.75	0.003088	2.40	29.17	28.08	0.41
Reach-1	17.6*	80.00	99.01	100.77	100.12	100.87	0.002942	2.47	32.36	28.70	0.41
Reach-1	17.6*	90.00	99.01	100.88	100.19	100.98	0.002847	2.55	35.36	29.27	0.41
Reach-1	17.6*	100.00	99.01	100.97	100.25	101.08	0.002760	2.61	38.25	29.67	0.41
Reach-1	17.6*	200.00	99.01	101.75	100.79	101.91	0.002467	3.21	62.25	31.99	0.41
Reach-1	17.6*	500.00	99.01	102.91	101.77	103.17	0.002493	4.35	187.54	221.24	0.44
Reach-1	17.6*	750.00	99.01	103.38	102.81	103.65	0.002517	4.81	314.35	316.89	0.45
Reach-1	17.6*	1000.00	99.01	103.72	103.24	103.99	0.002561	5.16	432.05	384.96	0.46
Reach-1	17.6*	1500.00	99.01	104.17	103.72	104.45	0.002609	5.61	615.46	402.00	0.48
Reach-1	17.4*	10.00	98.72	99.70	99.13	99.71	0.000552	0.78	12.77	18.09	0.16
Reach-1	17.4*	20.00	98.72	99.92	99.28	99.94	0.000962	1.19	16.88	19.43	0.22
Reach-1	17.4*	30.00	98.72	100.10	99.40	100.13	0.001247	1.47	20.39	20.58	0.26
Reach-1	17.4*	40.00	98.72	100.25	99.51	100.29	0.001462	1.70	23.60	21.66	0.29
Reach-1	17.4*	50.00	98.72	100.38	99.60	100.44	0.001627	1.88	26.60	22.64	0.31
Reach-1	17.4*	60.00	98.72	100.51	99.69	100.57	0.001818	2.03	29.52	24.28	0.32
Reach-1	17.4*	70.00	98.72	100.62	99.77	100.70	0.001978	2.16	32.45	26.00	0.34
Reach-1	17.4*	80.00	98.72	100.73	99.85	100.81	0.002092	2.26	35.42	27.64	0.35
Reach-1	17.4*	90.00	98.72	100.84	99.92	100.92	0.002158	2.35	38.35	28.90	0.36
Reach-1	17.4*	100.00	98.72	100.94	99.99	101.03	0.002146	2.43	41.23	29.43	0.36

Reach-1	17.4*	200.00	98.72	101.72	100.59	101.86	0.002145	3.05	65.53	32.66	0.38
Reach-1	17.4*	500.00	98.72	102.88	101.63	103.11	0.002251	4.18	194.92	225.30	0.42
Reach-1	17.4*	750.00	98.72	103.34	102.68	103.60	0.002331	4.66	321.61	319.59	0.43
Reach-1	17.4*	1000.00	98.72	103.67	103.14	103.94	0.002412	5.03	438.46	386.68	0.45
Reach-1	17.4*	1500.00	98.72	104.13	103.64	104.40	0.002496	5.51	621.20	402.50	0.46
Reach-1	17.2*	10.00	98.44	99.70	98.84	99.70	0.000214	0.59	17.04	18.08	0.11
Reach-1	17.2*	20.00	98.44	99.91	98.99	99.93	0.000461	0.95	21.05	19.19	0.16
Reach-1	17.2*	30.00	98.44	100.08	99.12	100.11	0.000673	1.23	24.44	20.12	0.20
Reach-1	17.2*	40.00	98.44	100.23	99.23	100.27	0.000859	1.45	27.50	21.03	0.22
Reach-1	17.2*	50.00	98.44	100.37	99.33	100.41	0.001018	1.65	30.35	21.84	0.25
Reach-1	17.2*	60.00	98.44	100.49	99.42	100.54	0.001155	1.82	33.06	22.59	0.26
Reach-1	17.2*	70.00	98.44	100.60	99.51	100.66	0.001312	1.96	35.67	23.84	0.28
Reach-1	17.2*	80.00	98.44	100.71	99.59	100.78	0.001465	2.09	38.30	25.35	0.30
Reach-1	17.2*	90.00	98.44	100.81	99.66	100.88	0.001599	2.20	40.91	26.77	0.31
Reach-1	17.2*	100.00	98.44	100.91	99.74	100.99	0.001708	2.29	43.58	28.13	0.32
Reach-1	17.2*	200.00	98.44	101.68	100.34	101.82	0.001988	2.95	67.75	33.29	0.36
Reach-1	17.2*	500.00	98.44	102.85	101.53	103.06	0.002084	4.02	203.69	231.45	0.40
Reach-1	17.2*	750.00	98.44	103.31	102.57	103.55	0.002179	4.51	332.20	324.80	0.42
Reach-1	17.2*	1000.00	98.44	103.64	103.05	103.89	0.002277	4.88	449.49	391.02	0.43
Reach-1	17.2*	1500.00	98.44	104.09	103.57	104.34	0.002390	5.38	630.29	403.00	0.45
Reach-1	17.*	10.00	98.15	99.70	98.55	99.70	0.000108	0.48	20.97	17.90	0.08
Reach-1	17.*	20.00	98.15	99.91	98.71	99.92	0.000264	0.80	24.88	18.85	0.12
Reach-1	17.*	30.00	98.15	100.08	98.84	100.10	0.000417	1.07	28.15	19.65	0.16
Reach-1	17.*	40.00	98.15	100.22	98.95	100.25	0.000563	1.29	31.09	20.43	0.18
Reach-1	17.*	50.00	98.15	100.36	99.06	100.39	0.000697	1.48	33.80	21.12	0.21
Reach-1	17.*	60.00	98.15	100.48	99.15	100.52	0.000820	1.65	36.37	21.76	0.22
Reach-1	17.*	70.00	98.15	100.59	99.24	100.64	0.000933	1.80	38.81	22.34	0.24
Reach-1	17.*	80.00	98.15	100.69	99.33	100.75	0.001055	1.94	41.18	23.24	0.26
Reach-1	17.*	90.00	98.15	100.79	99.41	100.85	0.001197	2.07	43.50	24.59	0.27
Reach-1	17.*	100.00	98.15	100.88	99.49	100.96	0.001324	2.18	45.87	25.90	0.29
Reach-1	17.*	200.00	98.15	101.65	100.12	101.78	0.001922	2.89	69.16	33.77	0.36
Reach-1	17.*	500.00	98.15	102.81	101.45	103.02	0.002004	3.91	209.83	236.20	0.39
Reach-1	17.*	750.00	98.15	103.27	102.48	103.50	0.002100	4.39	339.86	329.28	0.41
Reach-1	17.*	1000.00	98.15	103.60	102.98	103.84	0.002207	4.77	457.40	394.98	0.42
Reach-1	17.*	1500.00	98.15	104.04	103.50	104.29	0.002331	5.27	637.05	403.50	0.44
Reach-1	16.8	10.00	97.87	99.69	98.27	99.70	0.000067	0.41	24.29	17.56	0.06
Reach-1	16.8	20.00	97.87	99.91	98.43	99.91	0.000176	0.71	28.09	18.41	0.10
Reach-1	16.8	30.00	97.87	100.07	98.57	100.09	0.000293	0.96	31.25	19.10	0.13
Reach-1	16.8	40.00	97.87	100.22	98.69	100.24	0.000411	1.17	34.06	19.80	0.16
Reach-1	16.8	50.00	97.87	100.35	98.80	100.38	0.000526	1.36	36.65	20.42	0.18
Reach-1	16.8	60.00	97.87	100.46	98.90	100.50	0.000635	1.53	39.09	20.99	0.20
Reach-1	16.8	70.00	97.87	100.57	99.00	100.62	0.000739	1.69	41.40	21.51	0.21
Reach-1	16.8	80.00	97.87	100.68	99.09	100.73	0.000837	1.83	43.63	22.01	0.23
Reach-1	16.8	90.00	97.87	100.77	99.17	100.83	0.000932	1.97	45.73	22.47	0.24
Reach-1	16.8	100.00	97.87	100.86	99.25	100.93	0.001061	2.09	47.84	23.70	0.26
Reach-1	16.8	200.00	97.87	101.61	99.92	101.74	0.001948	2.88	69.38	33.84	0.35
Reach-1	16.8	500.00	97.87	102.78	101.37	102.98	0.002001	3.85	214.12	239.96	0.39
Reach-1	16.8	750.00	97.87	103.24	102.44	103.45	0.002082	4.30	345.63	332.82	0.40
Reach-1	16.8	1000.00	97.87	103.56	102.92	103.79	0.002189	4.67	463.24	397.91	0.42
Reach-1	16.8	1500.00	97.87	104.00	103.43	104.24	0.002314	5.17	642.10	404.00	0.44
Reach-1	16.6*	10.00	98.17	99.69	98.57	99.69	0.000107	0.47	21.34	18.63	0.08
Reach-1	16.6*	20.00	98.17	99.90	98.72	99.91	0.000260	0.79	25.31	19.63	0.12
Reach-1	16.6*	30.00	98.17	100.06	98.85	100.08	0.000415	1.05	28.62	20.55	0.16
Reach-1	16.6*	40.00	98.17	100.20	98.96	100.23	0.000560	1.27	31.57	21.34	0.18
Reach-1	16.6*	50.00	98.17	100.33	99.07	100.36	0.000695	1.46	34.30	22.05	0.21

Reach-1	16.6*										
Reach-1	16.6*	60.00	98.17	100.45	99.16	100.49	0.000819	1.63	36.87	22.70	0.22
Reach-1	16.6*	70.00	98.17	100.55	99.25	100.60	0.000969	1.78	39.34	24.07	0.25
Reach-1	16.6*	80.00	98.17	100.65	99.33	100.71	0.001113	1.91	41.83	25.48	0.26
Reach-1	16.6*	90.00	98.17	100.74	99.41	100.81	0.001246	2.03	44.26	26.79	0.28
Reach-1	16.6*	100.00	98.17	100.83	99.48	100.91	0.001366	2.14	46.72	28.06	0.29
Reach-1	16.6*	200.00	98.17	101.57	100.11	101.70	0.001846	2.86	69.84	33.78	0.35
Reach-1	16.6*	500.00	98.17	102.73	101.37	102.93	0.001936	3.89	213.72	239.68	0.39
Reach-1	16.6*	750.00	98.17	103.19	102.40	103.41	0.002051	4.38	343.69	331.79	0.41
Reach-1	16.6*	1000.00	98.17	103.50	102.89	103.74	0.002182	4.78	459.37	396.15	0.42
Reach-1	16.6*	1500.00	98.17	103.95	103.40	104.19	0.002326	5.30	636.82	403.25	0.45
Reach-1	16.4*										
Reach-1	16.4*	10.00	98.46	99.69	98.87	99.69	0.000217	0.57	17.46	19.60	0.11
Reach-1	16.4*	20.00	98.46	99.89	99.02	99.90	0.000474	0.93	21.53	20.95	0.16
Reach-1	16.4*	30.00	98.46	100.05	99.14	100.07	0.000701	1.20	24.96	22.09	0.20
Reach-1	16.4*	40.00	98.46	100.18	99.25	100.21	0.000910	1.43	28.03	23.33	0.23
Reach-1	16.4*	50.00	98.46	100.30	99.34	100.35	0.001125	1.61	30.98	25.12	0.26
Reach-1	16.4*	60.00	98.46	100.42	99.43	100.47	0.001308	1.77	33.88	26.78	0.28
Reach-1	16.4*	70.00	98.46	100.52	99.51	100.58	0.001466	1.91	36.73	28.31	0.29
Reach-1	16.4*	80.00	98.46	100.62	99.58	100.68	0.001553	2.02	39.56	29.12	0.31
Reach-1	16.4*	90.00	98.46	100.71	99.66	100.78	0.001617	2.13	42.24	29.61	0.31
Reach-1	16.4*	100.00	98.46	100.80	99.73	100.87	0.001666	2.23	44.87	30.02	0.32
Reach-1	16.4*	200.00	98.46	101.53	100.33	101.66	0.001937	2.95	67.86	32.97	0.36
Reach-1	16.4*	500.00	98.46	102.68	101.37	102.89	0.002001	4.00	211.90	240.00	0.39
Reach-1	16.4*	750.00	98.46	103.14	102.41	103.37	0.002106	4.48	342.04	332.02	0.41
Reach-1	16.4*	1000.00	98.46	103.45	102.87	103.70	0.002239	4.89	457.08	395.94	0.43
Reach-1	16.4*	1500.00	98.46	103.90	103.37	104.15	0.002356	5.38	636.01	402.50	0.45
Reach-1	16.2*										
Reach-1	16.2*	10.00	98.76	99.67	99.19	99.68	0.000717	0.81	12.36	20.47	0.18
Reach-1	16.2*	20.00	98.76	99.86	99.33	99.89	0.001264	1.22	16.40	22.41	0.25
Reach-1	16.2*	30.00	98.76	100.01	99.45	100.05	0.001709	1.50	19.94	24.92	0.30
Reach-1	16.2*	40.00	98.76	100.14	99.55	100.19	0.002026	1.72	23.31	27.16	0.33
Reach-1	16.2*	50.00	98.76	100.26	99.64	100.31	0.002141	1.88	26.53	27.96	0.34
Reach-1	16.2*	60.00	98.76	100.37	99.71	100.43	0.002211	2.03	29.59	28.62	0.35
Reach-1	16.2*	70.00	98.76	100.47	99.79	100.54	0.002271	2.15	32.49	29.22	0.36
Reach-1	16.2*	80.00	98.76	100.56	99.86	100.64	0.002281	2.26	35.33	29.52	0.36
Reach-1	16.2*	90.00	98.76	100.65	99.93	100.74	0.002298	2.37	37.99	29.75	0.37
Reach-1	16.2*	100.00	98.76	100.74	100.00	100.83	0.002306	2.46	40.58	29.98	0.37
Reach-1	16.2*	200.00	98.76	101.46	100.48	101.62	0.002380	3.18	62.86	31.86	0.40
Reach-1	16.2*	500.00	98.76	102.61	101.45	102.85	0.002333	4.24	200.92	234.55	0.43
Reach-1	16.2*	750.00	98.76	103.07	102.49	103.32	0.002393	4.71	329.02	326.95	0.44
Reach-1	16.2*	1000.00	98.76	103.39	102.89	103.65	0.002472	5.08	445.78	392.66	0.45
Reach-1	16.2*	1500.00	98.76	103.84	103.37	104.10	0.002532	5.53	626.59	401.75	0.47
Reach-1	16										
Reach-1	16	10.00	99.06	99.59	99.50	99.64	0.011061	1.87	5.36	19.78	0.63
Reach-1	16	20.00	99.06	99.74	99.64	99.82	0.011512	2.35	8.51	22.91	0.68
Reach-1	16	30.00	99.06	99.87	99.74	99.97	0.009806	2.57	11.69	24.42	0.65
Reach-1	16	40.00	99.06	99.99	99.83	100.11	0.008546	2.71	14.75	25.55	0.63
Reach-1	16	50.00	99.06	100.11	99.90	100.23	0.007620	2.80	17.88	27.09	0.61
Reach-1	16	60.00	99.06	100.23	99.96	100.35	0.006856	2.85	21.08	28.68	0.59
Reach-1	16	70.00	99.06	100.33	100.03	100.46	0.006033	2.90	24.12	28.87	0.56
Reach-1	16	80.00	99.06	100.43	100.09	100.57	0.005421	2.95	27.09	29.05	0.54
Reach-1	16	90.00	99.06	100.53	100.16	100.67	0.005059	3.02	29.78	29.21	0.53
Reach-1	16	100.00	99.06	100.62	100.21	100.76	0.004768	3.09	32.40	29.36	0.52
Reach-1	16	200.00	99.06	101.34	100.64	101.55	0.003749	3.69	54.14	30.62	0.49
Reach-1	16	500.00	99.06	102.49	101.62	102.79	0.003237	4.75	177.33	219.52	0.49
Reach-1	16	750.00	99.06	102.98	102.58	103.26	0.002997	5.07	308.10	318.16	0.49
Reach-1	16	1000.00	99.06	103.32	102.92	103.60	0.002927	5.34	428.10	387.16	0.49
Reach-1	16	1500.00	99.06	103.79	103.45	104.05	0.002806	5.66	616.39	401.00	0.49

Reach-1	15.8*	10.00	98.78	99.28	99.23	99.37	0.017558	2.40	4.17	14.92	0.80
Reach-1	15.8*	20.00	98.78	99.51	99.38	99.60	0.010452	2.47	8.08	18.70	0.66
Reach-1	15.8*	30.00	98.78	99.69	99.50	99.79	0.008350	2.55	11.76	21.90	0.61
Reach-1	15.8*	40.00	98.78	99.85	99.61	99.95	0.006842	2.61	15.32	23.68	0.57
Reach-1	15.8*	50.00	98.78	99.99	99.70	100.10	0.005906	2.67	18.74	25.07	0.54
Reach-1	15.8*	60.00	98.78	100.11	99.77	100.23	0.005330	2.73	22.00	26.33	0.53
Reach-1	15.8*	70.00	98.78	100.23	99.84	100.35	0.004975	2.78	25.15	27.69	0.51
Reach-1	15.8*	80.00	98.78	100.34	99.91	100.47	0.004769	2.82	28.32	29.53	0.51
Reach-1	15.8*	90.00	98.78	100.44	99.97	100.57	0.004404	2.87	31.36	29.99	0.49
Reach-1	15.8*	100.00	98.78	100.54	100.03	100.67	0.004090	2.92	34.27	30.16	0.48
Reach-1	15.8*	200.00	98.78	101.29	100.51	101.48	0.003197	3.49	57.34	31.45	0.46
Reach-1	15.8*	500.00	98.78	102.44	101.46	102.72	0.002908	4.57	181.89	220.55	0.47
Reach-1	15.8*	750.00	98.78	102.92	102.46	103.20	0.002787	4.95	311.30	317.93	0.47
Reach-1	15.8*	1000.00	98.78	103.26	102.83	103.54	0.002778	5.26	429.53	385.99	0.48
Reach-1	15.8*	1500.00	98.78	103.72	103.38	103.99	0.002731	5.63	615.79	401.50	0.48
Reach-1	15.6*	10.00	98.49	99.20	98.94	99.23	0.002918	1.36	7.35	15.98	0.35
Reach-1	15.6*	20.00	98.49	99.43	99.09	99.48	0.003307	1.77	11.27	18.02	0.40
Reach-1	15.6*	30.00	98.49	99.61	99.22	99.68	0.003486	2.04	14.68	19.67	0.42
Reach-1	15.6*	40.00	98.49	99.77	99.33	99.85	0.003614	2.24	17.86	21.39	0.43
Reach-1	15.6*	50.00	98.49	99.91	99.42	100.00	0.003722	2.37	21.06	23.58	0.44
Reach-1	15.6*	60.00	98.49	100.04	99.51	100.14	0.003636	2.48	24.22	24.96	0.44
Reach-1	15.6*	70.00	98.49	100.16	99.59	100.26	0.003568	2.57	27.26	26.22	0.44
Reach-1	15.6*	80.00	98.49	100.27	99.67	100.38	0.003498	2.64	30.25	27.40	0.44
Reach-1	15.6*	90.00	98.49	100.37	99.74	100.49	0.003472	2.72	33.15	28.68	0.45
Reach-1	15.6*	100.00	98.49	100.47	99.82	100.59	0.003474	2.77	36.06	30.23	0.45
Reach-1	15.6*	200.00	98.49	101.24	100.36	101.41	0.002797	3.32	60.33	32.27	0.43
Reach-1	15.6*	500.00	98.49	102.40	101.33	102.66	0.002633	4.40	187.64	223.32	0.45
Reach-1	15.6*	750.00	98.49	102.87	102.35	103.14	0.002591	4.81	316.80	319.85	0.45
Reach-1	15.6*	1000.00	98.49	103.21	102.74	103.48	0.002627	5.15	434.19	387.23	0.46
Reach-1	15.6*	1500.00	98.49	103.67	103.23	103.93	0.002636	5.56	618.65	402.00	0.47
Reach-1	15.4*	10.00	98.21	99.19	98.64	99.20	0.000701	0.87	11.51	16.65	0.18
Reach-1	15.4*	20.00	98.21	99.41	98.80	99.44	0.001199	1.30	15.37	18.06	0.25
Reach-1	15.4*	30.00	98.21	99.59	98.93	99.63	0.001555	1.61	18.63	19.26	0.29
Reach-1	15.4*	40.00	98.21	99.74	99.04	99.79	0.001820	1.85	21.62	20.36	0.32
Reach-1	15.4*	50.00	98.21	99.87	99.15	99.94	0.002016	2.04	24.46	21.38	0.34
Reach-1	15.4*	60.00	98.21	100.00	99.24	100.07	0.002288	2.20	27.27	23.46	0.36
Reach-1	15.4*	70.00	98.21	100.11	99.33	100.20	0.002426	2.33	30.08	24.85	0.37
Reach-1	15.4*	80.00	98.21	100.22	99.41	100.32	0.002517	2.43	32.88	26.10	0.38
Reach-1	15.4*	90.00	98.21	100.33	99.48	100.42	0.002594	2.53	35.59	27.26	0.39
Reach-1	15.4*	100.00	98.21	100.42	99.55	100.53	0.002648	2.61	38.29	28.36	0.40
Reach-1	15.4*	200.00	98.21	101.20	100.17	101.36	0.002523	3.18	62.93	33.09	0.41
Reach-1	15.4*	500.00	98.21	102.36	101.21	102.60	0.002394	4.22	195.54	227.84	0.43
Reach-1	15.4*	750.00	98.21	102.84	102.23	103.09	0.002400	4.65	325.49	322.99	0.44
Reach-1	15.4*	1000.00	98.21	103.16	102.65	103.42	0.002471	5.01	442.24	389.12	0.45
Reach-1	15.4*	1500.00	98.21	103.62	103.13	103.88	0.002530	5.46	624.73	402.50	0.46
Reach-1	15.2*	10.00	97.92	99.18	98.34	99.19	0.000253	0.63	15.87	17.08	0.12
Reach-1	15.2*	20.00	97.92	99.40	98.51	99.42	0.000539	1.01	19.72	18.22	0.17
Reach-1	15.2*	30.00	97.92	99.57	98.63	99.60	0.000790	1.31	22.92	19.17	0.21
Reach-1	15.2*	40.00	97.92	99.72	98.75	99.76	0.001008	1.55	25.81	20.07	0.24
Reach-1	15.2*	50.00	97.92	99.85	98.86	99.90	0.001191	1.75	28.54	20.88	0.26
Reach-1	15.2*	60.00	97.92	99.98	98.95	100.03	0.001350	1.93	31.11	21.62	0.28
Reach-1	15.2*	70.00	97.92	100.09	99.04	100.15	0.001553	2.08	33.61	23.12	0.30
Reach-1	15.2*	80.00	97.92	100.19	99.12	100.27	0.001731	2.21	36.15	24.64	0.32
Reach-1	15.2*	90.00	97.92	100.29	99.20	100.38	0.001867	2.33	38.64	25.82	0.34
Reach-1	15.2*	100.00	97.92	100.39	99.29	100.48	0.001981	2.43	41.14	26.95	0.35
Reach-1	15.2*	200.00	97.92	101.16	99.91	101.30	0.002318	3.06	65.28	33.84	0.39

Reach-1	15.2*	500.00	97.92	102.33	101.11	102.55	0.002221	4.08	202.15	232.05	0.41
Reach-1	15.2*	750.00	97.92	102.80	102.12	103.03	0.002258	4.52	333.10	326.75	0.42
Reach-1	15.2*	1000.00	97.92	103.12	102.56	103.37	0.002354	4.89	449.51	392.18	0.44
Reach-1	15.2*	1500.00	97.92	103.57	103.09	103.82	0.002444	5.37	630.49	403.00	0.46
Reach-1	15.*	10.00	97.64	99.18	98.04	99.19	0.000119	0.50	20.15	17.35	0.08
Reach-1	15.*	20.00	97.64	99.40	98.21	99.41	0.000288	0.83	24.01	18.33	0.13
Reach-1	15.*	30.00	97.64	99.57	98.34	99.59	0.000457	1.10	27.16	19.12	0.16
Reach-1	15.*	40.00	97.64	99.71	98.46	99.74	0.000618	1.33	30.00	19.91	0.19
Reach-1	15.*	50.00	97.64	99.84	98.57	99.88	0.000765	1.53	32.65	20.63	0.21
Reach-1	15.*	60.00	97.64	99.96	98.67	100.01	0.000900	1.71	35.15	21.27	0.23
Reach-1	15.*	70.00	97.64	100.07	98.77	100.13	0.001025	1.87	37.51	21.87	0.25
Reach-1	15.*	80.00	97.64	100.17	98.85	100.24	0.001169	2.01	39.81	22.93	0.27
Reach-1	15.*	90.00	97.64	100.27	98.93	100.34	0.001329	2.14	42.06	24.31	0.29
Reach-1	15.*	100.00	97.64	100.36	99.01	100.44	0.001465	2.25	44.36	25.53	0.30
Reach-1	15.*	200.00	97.64	101.12	99.66	101.26	0.002166	2.97	67.33	34.45	0.37
Reach-1	15.*	500.00	97.64	102.30	101.01	102.50	0.002085	3.95	208.93	236.69	0.40
Reach-1	15.*	750.00	97.64	102.76	102.02	102.98	0.002139	4.39	341.32	331.08	0.41
Reach-1	15.*	1000.00	97.64	103.08	102.47	103.32	0.002253	4.77	457.54	395.81	0.43
Reach-1	15.*	1500.00	97.64	103.53	102.99	103.77	0.002364	5.26	637.21	403.50	0.45
Reach-1	14.8	10.00	97.35	99.18	97.75	99.18	0.000066	0.41	24.42	17.59	0.06
Reach-1	14.8	20.00	97.35	99.40	97.91	99.40	0.000173	0.71	28.29	18.46	0.10
Reach-1	14.8	30.00	97.35	99.56	98.05	99.58	0.000288	0.95	31.43	19.14	0.13
Reach-1	14.8	40.00	97.35	99.71	98.17	99.73	0.000406	1.17	34.23	19.84	0.16
Reach-1	14.8	50.00	97.35	99.84	98.28	99.86	0.000519	1.36	36.84	20.46	0.18
Reach-1	14.8	60.00	97.35	99.95	98.38	99.99	0.000627	1.53	39.28	21.03	0.20
Reach-1	14.8	70.00	97.35	100.06	98.48	100.11	0.000731	1.68	41.57	21.55	0.21
Reach-1	14.8	80.00	97.35	100.16	98.57	100.21	0.000829	1.83	43.78	22.04	0.23
Reach-1	14.8	90.00	97.35	100.26	98.65	100.32	0.000927	1.96	45.86	22.54	0.24
Reach-1	14.8	100.00	97.35	100.35	98.73	100.41	0.001057	2.09	47.93	23.75	0.26
Reach-1	14.8	200.00	97.35	101.08	99.39	101.21	0.001962	2.89	69.16	33.75	0.36
Reach-1	14.8	500.00	97.35	102.26	100.85	102.46	0.001984	3.83	215.29	240.95	0.38
Reach-1	14.8	750.00	97.35	102.73	101.92	102.94	0.002048	4.27	348.96	334.84	0.40
Reach-1	14.8	1000.00	97.35	103.04	102.40	103.27	0.002178	4.66	464.57	398.59	0.42
Reach-1	14.8	1500.00	97.35	103.48	102.91	103.72	0.002306	5.16	642.97	404.00	0.44
Reach-1	14.6*	10.00	97.65	99.18	98.06	99.18	0.000121	0.49	20.23	17.85	0.08
Reach-1	14.6*	20.00	97.65	99.39	98.22	99.40	0.000294	0.83	24.09	18.88	0.13
Reach-1	14.6*	30.00	97.65	99.55	98.36	99.57	0.000471	1.10	27.23	19.80	0.17
Reach-1	14.6*	40.00	97.65	99.69	98.48	99.72	0.000638	1.33	30.03	20.59	0.19
Reach-1	14.6*	50.00	97.65	99.81	98.59	99.85	0.000790	1.53	32.66	21.30	0.22
Reach-1	14.6*	60.00	97.65	99.93	98.68	99.97	0.000932	1.71	35.11	21.94	0.24
Reach-1	14.6*	70.00	97.65	100.03	98.77	100.09	0.001116	1.87	37.47	23.48	0.26
Reach-1	14.6*	80.00	97.65	100.13	98.86	100.19	0.001280	2.01	39.85	24.87	0.28
Reach-1	14.6*	90.00	97.65	100.22	98.94	100.29	0.001423	2.13	42.16	25.98	0.30
Reach-1	14.6*	100.00	97.65	100.31	99.01	100.39	0.001552	2.25	44.46	27.04	0.31
Reach-1	14.6*	200.00	97.65	101.03	99.65	101.17	0.002146	2.97	67.25	34.25	0.37
Reach-1	14.6*	500.00	97.65	102.21	100.93	102.42	0.002058	3.95	211.12	239.10	0.39
Reach-1	14.6*	750.00	97.65	102.67	101.94	102.89	0.002135	4.41	342.32	332.11	0.41
Reach-1	14.6*	1000.00	97.65	102.99	102.39	103.22	0.002253	4.79	458.33	396.59	0.43
Reach-1	14.6*	1500.00	97.65	103.43	102.89	103.68	0.002368	5.28	637.14	403.25	0.45
Reach-1	14.4*	10.00	97.94	99.17	98.38	99.18	0.000275	0.63	15.82	18.20	0.12
Reach-1	14.4*	20.00	97.94	99.37	98.54	99.39	0.000595	1.02	19.64	19.62	0.18
Reach-1	14.4*	30.00	97.94	99.53	98.67	99.56	0.000884	1.32	22.77	20.75	0.22
Reach-1	14.4*	40.00	97.94	99.66	98.78	99.70	0.001168	1.56	25.58	22.19	0.26
Reach-1	14.4*	50.00	97.94	99.78	98.88	99.83	0.001440	1.76	28.35	24.01	0.29
Reach-1	14.4*	60.00	97.94	99.89	98.97	99.95	0.001640	1.93	31.05	25.26	0.31

Reach-1	14.4*	70.00	97.94	99.99	99.06	100.06	0.001816	2.08	33.63	26.39	0.33
Reach-1	14.4*	80.00	97.94	100.08	99.14	100.16	0.001962	2.21	36.18	27.47	0.34
Reach-1	14.4*	90.00	97.94	100.17	99.21	100.26	0.002093	2.33	38.63	28.47	0.35
Reach-1	14.4*	100.00	97.94	100.26	99.29	100.35	0.002214	2.43	41.07	29.54	0.36
Reach-1	14.4*	200.00	97.94	100.97	99.91	101.13	0.002373	3.12	64.16	33.14	0.39
Reach-1	14.4*	500.00	97.94	102.15	100.95	102.37	0.002240	4.12	203.83	235.36	0.41
Reach-1	14.4*	750.00	97.94	102.60	101.97	102.84	0.002303	4.58	332.98	328.29	0.43
Reach-1	14.4*	1000.00	97.94	102.93	102.39	103.18	0.002395	4.95	449.46	393.71	0.44
Reach-1	14.4*	1500.00	97.94	103.37	102.88	103.63	0.002479	5.42	629.48	402.50	0.46
Reach-1	14.2*	10.00	98.24	99.16	98.69	99.17	0.000939	0.90	11.12	19.19	0.21
Reach-1	14.2*	20.00	98.24	99.34	98.85	99.37	0.001677	1.34	14.89	21.69	0.29
Reach-1	14.2*	30.00	98.24	99.49	98.97	99.53	0.002187	1.65	18.17	23.67	0.33
Reach-1	14.2*	40.00	98.24	99.61	99.08	99.66	0.002512	1.89	21.16	24.92	0.36
Reach-1	14.2*	50.00	98.24	99.72	99.17	99.79	0.002733	2.08	24.03	26.06	0.38
Reach-1	14.2*	60.00	98.24	99.83	99.25	99.90	0.002886	2.24	26.81	27.12	0.40
Reach-1	14.2*	70.00	98.24	99.92	99.34	100.01	0.003049	2.38	29.45	28.34	0.41
Reach-1	14.2*	80.00	98.24	100.01	99.42	100.11	0.003194	2.49	32.12	29.82	0.42
Reach-1	14.2*	90.00	98.24	100.10	99.48	100.20	0.003216	2.59	34.73	30.51	0.43
Reach-1	14.2*	100.00	98.24	100.18	99.54	100.29	0.003165	2.68	37.28	30.65	0.43
Reach-1	14.2*	200.00	98.24	100.90	100.05	101.07	0.002864	3.35	59.63	31.91	0.43
Reach-1	14.2*	500.00	98.24	102.07	101.00	102.32	0.002567	4.36	194.35	230.43	0.44
Reach-1	14.2*	750.00	98.24	102.54	102.01	102.79	0.002543	4.78	324.21	325.11	0.45
Reach-1	14.2*	1000.00	98.24	102.87	102.39	103.13	0.002582	5.11	442.31	391.82	0.46
Reach-1	14.2*	1500.00	98.24	103.32	102.85	103.58	0.002609	5.54	624.02	401.75	0.47
Reach-1	14	10.00	98.54	99.06	98.98	99.12	0.012204	1.93	5.18	19.60	0.66
Reach-1	14	20.00	98.54	99.19	99.12	99.29	0.014573	2.55	7.84	22.28	0.76
Reach-1	14	30.00	98.54	99.31	99.22	99.43	0.012568	2.78	10.79	24.08	0.73
Reach-1	14	40.00	98.54	99.44	99.31	99.57	0.010380	2.89	13.84	25.22	0.69
Reach-1	14	50.00	98.54	99.55	99.38	99.69	0.008934	2.96	16.88	26.43	0.65
Reach-1	14	60.00	98.54	99.67	99.44	99.81	0.008165	3.01	19.91	28.39	0.63
Reach-1	14	70.00	98.54	99.77	99.51	99.91	0.007186	3.06	22.85	28.79	0.61
Reach-1	14	80.00	98.54	99.86	99.57	100.02	0.006467	3.12	25.65	28.96	0.58
Reach-1	14	90.00	98.54	99.96	99.64	100.11	0.005973	3.18	28.28	29.12	0.57
Reach-1	14	100.00	98.54	100.04	99.69	100.21	0.005578	3.24	30.85	29.27	0.56
Reach-1	14	200.00	98.54	100.78	100.12	101.00	0.004060	3.79	52.78	30.54	0.51
Reach-1	14	500.00	98.54	101.94	101.10	102.26	0.003387	4.83	171.96	214.51	0.50
Reach-1	14	750.00	98.54	102.44	102.06	102.73	0.003112	5.14	301.53	313.94	0.49
Reach-1	14	1000.00	98.54	102.78	102.40	103.07	0.003009	5.40	421.92	383.91	0.49
Reach-1	14	1500.00	98.54	103.25	102.93	103.52	0.002867	5.71	611.27	401.00	0.49
Reach-1	13.8*	10.00	98.26	98.73	98.69	98.82	0.018931	2.36	4.23	16.43	0.82
Reach-1	13.8*	20.00	98.26	98.96	98.83	99.05	0.010074	2.41	8.29	19.40	0.65
Reach-1	13.8*	30.00	98.26	99.13	98.95	99.23	0.007700	2.51	11.96	21.54	0.59
Reach-1	13.8*	40.00	98.26	99.29	99.04	99.39	0.006703	2.58	15.53	24.20	0.57
Reach-1	13.8*	50.00	98.26	99.43	99.13	99.54	0.005917	2.62	19.12	26.52	0.54
Reach-1	13.8*	60.00	98.26	99.56	99.21	99.67	0.005150	2.66	22.56	27.46	0.52
Reach-1	13.8*	70.00	98.26	99.68	99.28	99.79	0.004680	2.71	25.79	28.31	0.50
Reach-1	13.8*	80.00	98.26	99.78	99.35	99.90	0.004370	2.77	28.84	29.08	0.49
Reach-1	13.8*	90.00	98.26	99.88	99.42	100.01	0.004084	2.84	31.72	29.30	0.48
Reach-1	13.8*	100.00	98.26	99.97	99.47	100.11	0.003867	2.90	34.49	29.52	0.47
Reach-1	13.8*	200.00	98.26	100.73	99.93	100.92	0.003125	3.48	57.46	31.24	0.45
Reach-1	13.8*	500.00	98.26	101.90	100.90	102.19	0.002870	4.58	179.17	216.83	0.47
Reach-1	13.8*	750.00	98.26	102.38	101.92	102.67	0.002791	4.99	306.25	313.86	0.47
Reach-1	13.8*	1000.00	98.26	102.72	102.30	103.01	0.002780	5.30	424.53	382.67	0.48
Reach-1	13.8*	1500.00	98.26	103.18	102.87	103.46	0.002764	5.70	609.44	401.50	0.49
Reach-1	13.6*	10.00	97.97	98.67	98.39	98.69	0.002344	1.22	8.18	17.71	0.32

Reach-1	13.6*	20.00	97.97	98.90	98.54	98.94	0.002690	1.62	12.36	19.46	0.36
Reach-1	13.6*	30.00	97.97	99.08	98.65	99.13	0.002830	1.87	16.00	20.95	0.38
Reach-1	13.6*	40.00	97.97	99.23	98.75	99.30	0.002904	2.07	19.35	22.28	0.39
Reach-1	13.6*	50.00	97.97	99.37	98.85	99.45	0.003056	2.22	22.57	24.32	0.41
Reach-1	13.6*	60.00	97.97	99.50	98.92	99.58	0.003137	2.32	25.82	26.42	0.41
Reach-1	13.6*	70.00	97.97	99.62	99.01	99.71	0.003124	2.41	29.06	28.06	0.42
Reach-1	13.6*	80.00	97.97	99.73	99.08	99.82	0.002994	2.49	32.17	28.66	0.41
Reach-1	13.6*	90.00	97.97	99.83	99.15	99.93	0.002908	2.56	35.11	29.22	0.41
Reach-1	13.6*	100.00	97.97	99.92	99.21	100.03	0.002828	2.63	37.96	29.64	0.41
Reach-1	13.6*	200.00	97.97	100.69	99.75	100.86	0.002552	3.25	61.55	31.93	0.41
Reach-1	13.6*	500.00	97.97	101.87	100.73	102.13	0.002498	4.36	187.24	220.97	0.44
Reach-1	13.6*	750.00	97.97	102.34	101.77	102.61	0.002527	4.82	313.60	316.41	0.45
Reach-1	13.6*	1000.00	97.97	102.67	102.20	102.95	0.002573	5.17	430.95	384.38	0.46
		1500.00	97.97	103.13	102.68	103.41	0.002612	5.61	615.15	402.00	0.48
Reach-1	13.4*	10.00	97.68	98.66	98.09	98.67	0.000550	0.78	12.78	18.09	0.16
Reach-1	13.4*	20.00	97.68	98.88	98.24	98.90	0.000961	1.18	16.88	19.43	0.22
Reach-1	13.4*	30.00	97.68	99.06	98.36	99.09	0.001246	1.47	20.40	20.58	0.26
Reach-1	13.4*	40.00	97.68	99.21	98.47	99.25	0.001462	1.70	23.59	21.66	0.29
Reach-1	13.4*	50.00	97.68	99.34	98.56	99.40	0.001632	1.88	26.58	22.63	0.31
Reach-1	13.4*	60.00	97.68	99.47	98.65	99.53	0.001826	2.04	29.46	24.24	0.33
Reach-1	13.4*	70.00	97.68	99.58	98.73	99.65	0.001994	2.16	32.34	25.94	0.34
Reach-1	13.4*	80.00	97.68	99.69	98.81	99.77	0.002120	2.27	35.23	27.54	0.35
Reach-1	13.4*	90.00	97.68	99.79	98.88	99.88	0.002204	2.36	38.08	28.85	0.36
Reach-1	13.4*	100.00	97.68	99.89	98.95	99.98	0.002197	2.44	40.91	29.37	0.37
Reach-1	13.4*	200.00	97.68	100.66	99.55	100.80	0.002220	3.09	64.77	32.56	0.39
Reach-1	13.4*	500.00	97.68	101.83	100.59	102.07	0.002256	4.18	194.60	225.00	0.42
Reach-1	13.4*	750.00	97.68	102.30	101.64	102.55	0.002341	4.67	320.79	319.07	0.44
Reach-1	13.4*	1000.00	97.68	102.63	102.10	102.90	0.002424	5.04	437.28	386.06	0.45
		1500.00	97.68	103.09	102.60	103.36	0.002499	5.51	620.85	402.50	0.47
Reach-1	13.2*	10.00	97.40	98.66	97.80	98.66	0.000214	0.59	17.05	18.08	0.11
Reach-1	13.2*	20.00	97.40	98.87	97.95	98.89	0.000460	0.95	21.05	19.19	0.16
Reach-1	13.2*	30.00	97.40	99.04	98.08	99.07	0.000673	1.23	24.44	20.12	0.20
Reach-1	13.2*	40.00	97.40	99.19	98.19	99.23	0.000859	1.45	27.50	21.03	0.22
Reach-1	13.2*	50.00	97.40	99.33	98.29	99.37	0.001021	1.65	30.32	21.84	0.25
Reach-1	13.2*	60.00	97.40	99.45	98.38	99.50	0.001160	1.82	33.00	22.57	0.26
Reach-1	13.2*	70.00	97.40	99.56	98.47	99.62	0.001321	1.97	35.56	23.78	0.28
Reach-1	13.2*	80.00	97.40	99.66	98.55	99.73	0.001481	2.10	38.12	25.25	0.30
Reach-1	13.2*	90.00	97.40	99.76	98.62	99.83	0.001622	2.21	40.65	26.63	0.32
Reach-1	13.2*	100.00	97.40	99.85	98.70	99.94	0.001738	2.31	43.25	27.97	0.33
Reach-1	13.2*	200.00	97.40	100.62	99.30	100.76	0.002058	2.99	66.93	33.15	0.37
Reach-1	13.2*	500.00	97.40	101.80	100.49	102.02	0.002090	4.03	203.33	231.14	0.40
Reach-1	13.2*	750.00	97.40	102.26	101.53	102.50	0.002189	4.52	331.29	324.24	0.42
Reach-1	13.2*	1000.00	97.40	102.59	102.02	102.84	0.002288	4.89	448.25	390.38	0.44
		1500.00	97.40	103.04	102.53	103.30	0.002394	5.38	629.92	403.00	0.45
Reach-1	13.*	10.00	97.12	98.66	97.51	98.66	0.000109	0.48	20.92	17.90	0.08
Reach-1	13.*	20.00	97.12	98.87	97.67	98.88	0.000266	0.81	24.82	18.86	0.12
Reach-1	13.*	30.00	97.12	99.04	97.80	99.06	0.000420	1.07	28.10	19.65	0.16
Reach-1	13.*	40.00	97.12	99.18	97.92	99.21	0.000567	1.29	31.03	20.42	0.18
Reach-1	13.*	50.00	97.12	99.31	98.02	99.35	0.000703	1.48	33.72	21.11	0.21
Reach-1	13.*	60.00	97.12	99.43	98.12	99.47	0.000828	1.65	36.26	21.74	0.23
Reach-1	13.*	70.00	97.12	99.54	98.21	99.59	0.000945	1.81	38.65	22.32	0.24
Reach-1	13.*	80.00	97.12	99.64	98.29	99.70	0.001068	1.95	40.95	23.14	0.26
Reach-1	13.*	90.00	97.12	99.74	98.37	99.80	0.001216	2.08	43.19	24.45	0.28
Reach-1	13.*	100.00	97.12	99.83	98.45	99.90	0.001349	2.20	45.50	25.73	0.29
Reach-1	13.*	200.00	97.12	100.58	99.08	100.72	0.001994	2.93	68.22	33.56	0.36
Reach-1	13.*	500.00	97.12	101.77	100.41	101.98	0.002013	3.92	209.36	235.85	0.39

Reach-1	13.*	750.00	97.12	102.23	101.45	102.46	0.002113	4.40	338.83	328.68	0.41
Reach-1	13.*	1000.00	97.12	102.55	101.95	102.79	0.002219	4.78	456.13	394.36	0.43
Reach-1	13.*	1500.00	97.12	103.00	102.46	103.25	0.002336	5.27	636.67	403.50	0.44
Reach-1	12.8	10.00	96.83	98.65	97.23	98.66	0.000067	0.41	24.30	17.56	0.06
Reach-1	12.8	20.00	96.83	98.87	97.39	98.87	0.000176	0.71	28.09	18.42	0.10
Reach-1	12.8	30.00	96.83	99.03	97.53	99.05	0.000293	0.96	31.25	19.10	0.13
Reach-1	12.8	40.00	96.83	99.18	97.65	99.20	0.000412	1.17	34.05	19.79	0.16
Reach-1	12.8	50.00	96.83	99.31	97.76	99.33	0.000527	1.37	36.62	20.41	0.18
Reach-1	12.8	60.00	96.83	99.42	97.86	99.46	0.000638	1.54	39.03	20.97	0.20
Reach-1	12.8	70.00	96.83	99.53	97.96	99.57	0.000744	1.70	41.30	21.49	0.22
Reach-1	12.8	80.00	96.83	99.63	98.05	99.68	0.000846	1.84	43.46	21.97	0.23
Reach-1	12.8	90.00	96.83	99.72	98.13	99.78	0.000945	1.98	45.50	22.41	0.24
Reach-1	12.8	100.00	96.83	99.81	98.21	99.88	0.001073	2.10	47.55	23.54	0.26
Reach-1	12.8	200.00	96.83	100.54	98.88	100.68	0.002007	2.92	68.45	33.47	0.36
Reach-1	12.8	500.00	96.83	101.74	100.33	101.93	0.002007	3.85	213.67	239.58	0.39
Reach-1	12.8	750.00	96.83	102.19	101.40	102.41	0.002093	4.31	344.51	332.14	0.40
Reach-1	12.8	1000.00	96.83	102.52	101.88	102.74	0.002202	4.68	461.82	397.19	0.42
Reach-1	12.8	1500.00	96.83	102.96	102.39	103.20	0.002318	5.17	641.64	404.00	0.44
Reach-1	12.6*	10.00	97.13	98.65	97.53	98.66	0.000106	0.47	21.35	18.63	0.08
Reach-1	12.6*	20.00	97.13	98.86	97.68	98.87	0.000260	0.79	25.31	19.63	0.12
Reach-1	12.6*	30.00	97.13	99.02	97.81	99.04	0.000414	1.05	28.62	20.55	0.16
Reach-1	12.6*	40.00	97.13	99.16	97.92	99.19	0.000560	1.27	31.57	21.34	0.18
Reach-1	12.6*	50.00	97.13	99.29	98.02	99.32	0.000697	1.46	34.27	22.04	0.21
Reach-1	12.6*	60.00	97.13	99.40	98.12	99.44	0.000822	1.63	36.81	22.68	0.23
Reach-1	12.6*	70.00	97.13	99.51	98.21	99.56	0.000976	1.78	39.22	24.00	0.25
Reach-1	12.6*	80.00	97.13	99.60	98.29	99.66	0.001125	1.92	41.63	25.37	0.26
Reach-1	12.6*	90.00	97.13	99.69	98.37	99.76	0.001264	2.05	43.97	26.64	0.28
Reach-1	12.6*	100.00	97.13	99.78	98.44	99.85	0.001389	2.16	46.36	27.88	0.29
Reach-1	12.6*	200.00	97.13	100.50	99.07	100.64	0.001919	2.90	68.86	33.59	0.36
Reach-1	12.6*	500.00	97.13	101.69	100.33	101.89	0.001942	3.90	213.21	239.25	0.39
Reach-1	12.6*	750.00	97.13	102.14	101.35	102.37	0.002063	4.39	342.43	331.02	0.41
Reach-1	12.6*	1000.00	97.13	102.46	101.85	102.70	0.002196	4.79	457.77	395.33	0.43
Reach-1	12.6*	1500.00	97.13	102.90	102.36	103.15	0.002332	5.30	636.13	403.25	0.45
Reach-1	12.4*	10.00	97.43	98.65	97.84	98.65	0.000220	0.57	17.40	19.60	0.11
Reach-1	12.4*	20.00	97.43	98.85	97.99	98.86	0.000478	0.93	21.47	20.95	0.16
Reach-1	12.4*	30.00	97.43	99.01	98.10	99.03	0.000707	1.21	24.89	22.09	0.20
Reach-1	12.4*	40.00	97.43	99.14	98.21	99.17	0.000918	1.43	27.96	23.32	0.23
Reach-1	12.4*	50.00	97.43	99.26	98.31	99.30	0.001137	1.62	30.87	25.10	0.26
Reach-1	12.4*	60.00	97.43	99.37	98.39	99.42	0.001325	1.78	33.73	26.73	0.28
Reach-1	12.4*	70.00	97.43	99.47	98.47	99.53	0.001490	1.92	36.50	28.22	0.30
Reach-1	12.4*	80.00	97.43	99.57	98.55	99.63	0.001592	2.04	39.24	29.07	0.31
Reach-1	12.4*	90.00	97.43	99.66	98.62	99.73	0.001666	2.15	41.82	29.54	0.32
Reach-1	12.4*	100.00	97.43	99.74	98.69	99.82	0.001723	2.25	44.38	29.96	0.33
Reach-1	12.4*	200.00	97.43	100.46	99.29	100.60	0.002033	3.00	66.74	32.80	0.37
Reach-1	12.4*	500.00	97.43	101.63	100.33	101.85	0.002042	4.03	208.45	237.17	0.40
Reach-1	12.4*	750.00	97.43	102.09	101.38	102.32	0.002166	4.53	336.06	328.64	0.42
Reach-1	12.4*	1000.00	97.43	102.40	101.84	102.66	0.002299	4.94	450.25	392.83	0.44
Reach-1	12.4*	1500.00	97.43	102.85	102.34	103.11	0.002415	5.44	629.52	402.50	0.46
Reach-1	12.2*	10.00	97.72	98.63	98.15	98.64	0.000716	0.81	12.37	20.47	0.18
Reach-1	12.2*	20.00	97.72	98.82	98.29	98.85	0.001263	1.22	16.40	22.41	0.25
Reach-1	12.2*	30.00	97.72	98.97	98.41	99.01	0.001708	1.50	19.94	24.92	0.30
Reach-1	12.2*	40.00	97.72	99.10	98.51	99.15	0.002030	1.72	23.29	27.16	0.33
Reach-1	12.2*	50.00	97.72	99.22	98.59	99.27	0.002153	1.89	26.48	27.95	0.34
Reach-1	12.2*	60.00	97.72	99.32	98.67	99.39	0.002235	2.03	29.49	28.59	0.35
Reach-1	12.2*	70.00	97.72	99.42	98.75	99.49	0.002311	2.17	32.30	29.18	0.36

Reach-1	12.2*	80.00	97.72	99.51	98.82	99.59	0.002344	2.28	35.02	29.49	0.37
Reach-1	12.2*	90.00	97.72	99.60	98.89	99.69	0.002378	2.40	37.58	29.72	0.38
Reach-1	12.2*	100.00	97.72	99.68	98.96	99.78	0.002395	2.49	40.09	29.94	0.38
Reach-1	12.2*	200.00	97.72	100.39	99.44	100.55	0.002514	3.24	61.75	31.77	0.41
Reach-1	12.2*	500.00	97.72	101.56	100.41	101.81	0.002349	4.26	199.97	233.73	0.43
Reach-1	12.2*	750.00	97.72	102.02	101.46	102.27	0.002425	4.74	326.50	325.39	0.44
Reach-1	12.2*	1000.00	97.72	102.34	101.85	102.61	0.002499	5.10	443.13	391.29	0.46
Reach-1	12.2*	1500.00	97.72	102.80	102.33	103.06	0.002540	5.53	625.78	401.75	0.47
Reach-1	12	10.00	98.02	98.55	98.46	98.60	0.010922	1.86	5.38	19.81	0.63
Reach-1	12	20.00	98.02	98.70	98.60	98.78	0.011503	2.35	8.51	22.91	0.68
Reach-1	12	30.00	98.02	98.83	98.70	98.93	0.009798	2.57	11.69	24.42	0.65
Reach-1	12	40.00	98.02	98.95	98.79	99.07	0.008605	2.72	14.72	25.54	0.63
Reach-1	12	50.00	98.02	99.07	98.86	99.19	0.007741	2.81	17.78	27.03	0.61
Reach-1	12	60.00	98.02	99.18	98.92	99.31	0.007075	2.87	20.88	28.67	0.59
Reach-1	12	70.00	98.02	99.28	98.99	99.42	0.006311	2.94	23.79	28.85	0.57
Reach-1	12	80.00	98.02	99.38	99.05	99.52	0.005756	3.01	26.59	29.02	0.55
Reach-1	12	90.00	98.02	99.47	99.12	99.61	0.005425	3.09	29.14	29.17	0.54
Reach-1	12	100.00	98.02	99.55	99.17	99.71	0.005129	3.16	31.67	29.32	0.54
Reach-1	12	200.00	98.02	100.26	99.60	100.48	0.004067	3.79	52.75	30.54	0.51
Reach-1	12	500.00	98.02	101.44	100.58	101.75	0.003273	4.77	176.00	218.29	0.49
Reach-1	12	750.00	98.02	101.93	101.54	102.22	0.003051	5.10	304.98	316.16	0.49
Reach-1	12	1000.00	98.02	102.27	101.88	102.55	0.002976	5.37	424.35	385.19	0.49
Reach-1	12	1500.00	98.02	102.74	102.41	103.01	0.002824	5.67	614.83	401.00	0.49
Reach-1	11.8*	10.00	97.74	98.23	98.19	98.33	0.018250	2.43	4.11	14.82	0.81
Reach-1	11.8*	20.00	97.74	98.47	98.34	98.56	0.010484	2.48	8.07	18.69	0.66
Reach-1	11.8*	30.00	97.74	98.65	98.46	98.75	0.008331	2.55	11.77	21.91	0.61
Reach-1	11.8*	40.00	97.74	98.80	98.57	98.91	0.006956	2.63	15.23	23.65	0.58
Reach-1	11.8*	50.00	97.74	98.94	98.66	99.05	0.006082	2.70	18.55	25.00	0.55
Reach-1	11.8*	60.00	97.74	99.06	98.73	99.18	0.005567	2.77	21.67	26.20	0.54
Reach-1	11.8*	70.00	97.74	99.17	98.80	99.30	0.005235	2.84	24.66	27.39	0.53
Reach-1	11.8*	80.00	97.74	99.28	98.87	99.41	0.005108	2.90	27.59	29.12	0.53
Reach-1	11.8*	90.00	97.74	99.37	98.93	99.51	0.004860	2.96	30.41	29.93	0.52
Reach-1	11.8*	100.00	97.74	99.47	98.99	99.61	0.004503	3.01	33.25	30.10	0.50
Reach-1	11.8*	200.00	97.74	100.20	99.47	100.40	0.003496	3.59	55.74	31.36	0.47
Reach-1	11.8*	500.00	97.74	101.39	100.42	101.68	0.002943	4.59	180.38	219.16	0.47
Reach-1	11.8*	750.00	97.74	101.87	101.42	102.15	0.002843	4.99	307.67	315.61	0.47
Reach-1	11.8*	1000.00	97.74	102.21	101.79	102.49	0.002829	5.29	425.39	383.80	0.48
Reach-1	11.8*	1500.00	97.74	102.68	102.34	102.95	0.002753	5.65	613.86	401.50	0.48
Reach-1	11.6*	10.00	97.45	98.15	97.90	98.18	0.003114	1.39	7.19	15.89	0.36
Reach-1	11.6*	20.00	97.45	98.39	98.05	98.44	0.003319	1.78	11.26	18.01	0.40
Reach-1	11.6*	30.00	97.45	98.57	98.18	98.64	0.003477	2.04	14.69	19.68	0.42
Reach-1	11.6*	40.00	97.45	98.72	98.29	98.80	0.003664	2.25	17.76	21.30	0.43
Reach-1	11.6*	50.00	97.45	98.86	98.38	98.95	0.003843	2.40	20.82	23.47	0.45
Reach-1	11.6*	60.00	97.45	98.98	98.47	99.08	0.003810	2.52	23.81	24.78	0.45
Reach-1	11.6*	70.00	97.45	99.10	98.55	99.20	0.003787	2.62	26.68	25.98	0.46
Reach-1	11.6*	80.00	97.45	99.20	98.63	99.31	0.003783	2.72	29.41	27.07	0.46
Reach-1	11.6*	90.00	97.45	99.30	98.71	99.42	0.003782	2.81	32.04	28.09	0.46
Reach-1	11.6*	100.00	97.45	99.39	98.78	99.52	0.003788	2.87	34.84	29.59	0.47
Reach-1	11.6*	200.00	97.45	100.15	99.32	100.33	0.003081	3.42	58.49	32.17	0.45
Reach-1	11.6*	500.00	97.45	101.35	100.29	101.62	0.002668	4.42	185.95	221.78	0.45
Reach-1	11.6*	750.00	97.45	101.82	101.31	102.09	0.002650	4.85	312.66	317.21	0.46
Reach-1	11.6*	1000.00	97.45	102.16	101.70	102.43	0.002679	5.19	429.67	384.86	0.47
Reach-1	11.6*	1500.00	97.45	102.62	102.19	102.89	0.002662	5.59	616.31	402.00	0.48
Reach-1	11.4*	10.00	97.16	98.14	97.60	98.15	0.000720	0.88	11.40	16.58	0.19
Reach-1	11.4*	20.00	97.16	98.37	97.75	98.40	0.001186	1.30	15.42	18.06	0.25

Reach-1	11.4*	30.00	97.16	98.55	97.88	98.59	0.001534	1.60	18.72	19.27	0.29
Reach-1	11.4*	40.00	97.16	98.69	98.00	98.74	0.001827	1.85	21.58	20.33	0.32
Reach-1	11.4*	50.00	97.16	98.82	98.10	98.89	0.002050	2.06	24.29	21.28	0.34
Reach-1	11.4*	60.00	97.16	98.94	98.19	99.02	0.002349	2.23	26.92	23.17	0.36
Reach-1	11.4*	70.00	97.16	99.05	98.28	99.14	0.002540	2.37	29.53	24.57	0.38
Reach-1	11.4*	80.00	97.16	99.15	98.36	99.25	0.002686	2.50	32.05	25.71	0.39
Reach-1	11.4*	90.00	97.16	99.24	98.44	99.35	0.002812	2.61	34.49	26.76	0.41
Reach-1	11.4*	100.00	97.16	99.34	98.51	99.45	0.002877	2.70	37.07	27.84	0.41
Reach-1	11.4*	200.00	97.16	100.10	99.13	100.26	0.002789	3.28	60.93	32.96	0.43
Reach-1	11.4*	500.00	97.16	101.32	100.17	101.56	0.002424	4.24	193.72	226.18	0.43
Reach-1	11.4*	750.00	97.16	101.78	101.19	102.04	0.002457	4.70	320.88	320.07	0.44
Reach-1	11.4*	1000.00	97.16	102.11	101.60	102.37	0.002521	5.05	437.29	386.51	0.46
Reach-1	11.4*	1500.00	97.16	102.57	102.09	102.83	0.002557	5.49	622.01	402.50	0.47
Reach-1	11.2*	10.00	96.88	98.13	97.30	98.14	0.000262	0.64	15.69	17.03	0.12
Reach-1	11.2*	20.00	96.88	98.36	97.47	98.38	0.000540	1.01	19.71	18.21	0.17
Reach-1	11.2*	30.00	96.88	98.53	97.59	98.56	0.000788	1.31	22.94	19.18	0.21
Reach-1	11.2*	40.00	96.88	98.68	97.71	98.71	0.001019	1.56	25.71	20.04	0.24
Reach-1	11.2*	50.00	96.88	98.80	97.82	98.85	0.001219	1.77	28.30	20.81	0.27
Reach-1	11.2*	60.00	96.88	98.92	97.91	98.98	0.001398	1.95	30.72	21.51	0.29
Reach-1	11.2*	70.00	96.88	99.02	98.00	99.09	0.001610	2.12	33.02	22.72	0.31
Reach-1	11.2*	80.00	96.88	99.12	98.08	99.20	0.001836	2.27	35.26	24.20	0.33
Reach-1	11.2*	90.00	96.88	99.21	98.16	99.30	0.002011	2.40	37.47	25.28	0.35
Reach-1	11.2*	100.00	96.88	99.30	98.25	99.40	0.002140	2.51	39.85	26.37	0.36
Reach-1	11.2*	200.00	96.88	100.05	98.87	100.21	0.002589	3.17	63.00	33.67	0.41
Reach-1	11.2*	500.00	96.88	101.28	100.07	101.51	0.002255	4.10	200.09	230.26	0.41
Reach-1	11.2*	750.00	96.88	101.74	101.08	101.98	0.002319	4.57	327.98	323.57	0.43
Reach-1	11.2*	1000.00	96.88	102.07	101.52	102.32	0.002405	4.93	444.30	389.49	0.44
Reach-1	11.2*	1500.00	96.88	102.52	102.05	102.78	0.002473	5.39	627.48	403.00	0.46
Reach-1	11.*	10.00	96.60	98.13	97.00	98.14	0.000122	0.50	19.97	17.30	0.08
Reach-1	11.*	20.00	96.60	98.36	97.17	98.37	0.000289	0.83	24.00	18.32	0.13
Reach-1	11.*	30.00	96.60	98.53	97.30	98.55	0.000456	1.10	27.19	19.13	0.16
Reach-1	11.*	40.00	96.60	98.67	97.42	98.69	0.000624	1.34	29.89	19.88	0.19
Reach-1	11.*	50.00	96.60	98.79	97.53	98.83	0.000780	1.54	32.42	20.56	0.22
Reach-1	11.*	60.00	96.60	98.90	97.63	98.95	0.000928	1.73	34.75	21.17	0.24
Reach-1	11.*	70.00	96.60	99.01	97.73	99.06	0.001069	1.89	36.94	21.73	0.26
Reach-1	11.*	80.00	96.60	99.10	97.81	99.16	0.001217	2.05	38.97	22.39	0.27
Reach-1	11.*	90.00	96.60	99.18	97.89	99.26	0.001402	2.20	40.94	23.63	0.29
Reach-1	11.*	100.00	96.60	99.27	97.97	99.36	0.001561	2.32	43.10	24.90	0.31
Reach-1	11.*	200.00	96.60	100.01	98.62	100.15	0.002427	3.09	64.83	34.16	0.39
Reach-1	11.*	500.00	96.60	101.25	99.97	101.46	0.002119	3.97	206.67	234.75	0.40
Reach-1	11.*	750.00	96.60	101.70	100.98	101.93	0.002201	4.44	335.68	327.61	0.42
Reach-1	11.*	1000.00	96.60	102.03	101.43	102.27	0.002305	4.82	451.97	392.95	0.43
Reach-1	11.*	1500.00	96.60	102.48	101.95	102.73	0.002395	5.29	633.86	403.50	0.45
Reach-1	10.8	10.00	96.31	98.13	96.71	98.13	0.000067	0.41	24.24	17.55	0.06
Reach-1	10.8	20.00	96.31	98.36	96.87	98.36	0.000173	0.71	28.28	18.46	0.10
Reach-1	10.8	30.00	96.31	98.52	97.01	98.54	0.000288	0.95	31.46	19.15	0.13
Reach-1	10.8	40.00	96.31	98.66	97.13	98.68	0.000409	1.17	34.13	19.81	0.16
Reach-1	10.8	50.00	96.31	98.78	97.24	98.81	0.000528	1.37	36.60	20.41	0.18
Reach-1	10.8	60.00	96.31	98.89	97.34	98.93	0.000644	1.54	38.88	20.94	0.20
Reach-1	10.8	70.00	96.31	99.00	97.44	99.04	0.000759	1.71	41.01	21.42	0.22
Reach-1	10.8	80.00	96.31	99.09	97.53	99.14	0.000873	1.86	42.96	21.86	0.23
Reach-1	10.8	90.00	96.31	99.17	97.61	99.23	0.000985	2.01	44.80	22.26	0.25
Reach-1	10.8	100.00	96.31	99.26	97.69	99.33	0.001107	2.14	46.75	23.07	0.26
Reach-1	10.8	200.00	96.31	99.97	98.35	100.11	0.002135	3.00	66.61	32.71	0.37
Reach-1	10.8	500.00	96.31	101.21	99.81	101.41	0.002019	3.86	212.81	238.86	0.39
Reach-1	10.8	750.00	96.31	101.67	100.88	101.89	0.002112	4.33	342.77	331.08	0.41

Reach-1	10.8	1000.00	96.31	101.99	101.36	102.22	0.002231	4.71	458.60	395.55	0.42
Reach-1	10.8	1500.00	96.31	102.44	101.87	102.67	0.002340	5.19	639.26	404.00	0.44
Reach-1	10.6*	10.00	96.61	98.13	97.02	98.13	0.000125	0.50	20.04	17.80	0.08
Reach-1	10.6*	20.00	96.61	98.35	97.18	98.36	0.000295	0.83	24.08	18.88	0.13
Reach-1	10.6*	30.00	96.61	98.51	97.32	98.53	0.000469	1.10	27.25	19.81	0.17
Reach-1	10.6*	40.00	96.61	98.64	97.44	98.67	0.000644	1.34	29.92	20.56	0.20
Reach-1	10.6*	50.00	96.61	98.76	97.55	98.80	0.000808	1.54	32.40	21.23	0.22
Reach-1	10.6*	60.00	96.61	98.87	97.64	98.92	0.000964	1.73	34.68	21.83	0.24
Reach-1	10.6*	70.00	96.61	98.96	97.73	99.02	0.001155	1.90	36.83	23.07	0.27
Reach-1	10.6*	80.00	96.61	99.05	97.82	99.12	0.001353	2.06	38.87	24.36	0.29
Reach-1	10.6*	90.00	96.61	99.13	97.90	99.21	0.001530	2.20	40.86	25.36	0.31
Reach-1	10.6*	100.00	96.61	99.21	97.97	99.30	0.001677	2.32	43.01	26.38	0.32
Reach-1	10.6*	200.00	96.61	99.91	98.61	100.06	0.002453	3.11	64.38	33.99	0.40
Reach-1	10.6*	500.00	96.61	101.16	99.89	101.37	0.002100	3.98	208.31	236.71	0.40
Reach-1	10.6*	750.00	96.61	101.61	100.90	101.84	0.002211	4.47	335.43	327.89	0.42
Reach-1	10.6*	1000.00	96.61	101.93	101.35	102.17	0.002316	4.85	451.53	393.10	0.43
Reach-1	10.6*	1500.00	96.61	102.38	101.85	102.63	0.002409	5.32	632.87	403.25	0.45
Reach-1	10.4*	10.00	96.90	98.12	97.34	98.13	0.000285	0.64	15.63	18.13	0.12
Reach-1	10.4*	20.00	96.90	98.33	97.49	98.35	0.000596	1.02	19.63	19.61	0.18
Reach-1	10.4*	30.00	96.90	98.49	97.62	98.52	0.000881	1.32	22.80	20.76	0.22
Reach-1	10.4*	40.00	96.90	98.62	97.74	98.65	0.001181	1.57	25.46	22.09	0.26
Reach-1	10.4*	50.00	96.90	98.73	97.84	98.78	0.001481	1.78	28.04	23.87	0.29
Reach-1	10.4*	60.00	96.90	98.83	97.93	98.89	0.001717	1.97	30.50	25.01	0.31
Reach-1	10.4*	70.00	96.90	98.92	98.02	98.99	0.001933	2.13	32.82	26.05	0.33
Reach-1	10.4*	80.00	96.90	99.00	98.10	99.08	0.002142	2.29	34.97	26.97	0.35
Reach-1	10.4*	90.00	96.90	99.08	98.17	99.17	0.002338	2.43	37.03	27.83	0.37
Reach-1	10.4*	100.00	96.90	99.16	98.25	99.26	0.002473	2.54	39.29	28.74	0.38
Reach-1	10.4*	200.00	96.90	99.84	98.87	100.01	0.002774	3.28	61.04	32.97	0.42
Reach-1	10.4*	500.00	96.90	101.10	99.91	101.32	0.002260	4.13	203.31	234.88	0.42
Reach-1	10.4*	750.00	96.90	101.55	100.93	101.79	0.002355	4.62	329.28	325.77	0.43
Reach-1	10.4*	1000.00	96.90	101.87	101.35	102.13	0.002429	4.98	446.63	391.90	0.45
Reach-1	10.4*	1500.00	96.90	102.33	101.83	102.58	0.002484	5.42	629.32	402.50	0.46
Reach-1	10.2*	10.00	97.20	98.10	97.65	98.12	0.000995	0.92	10.90	19.07	0.21
Reach-1	10.2*	20.00	97.20	98.30	97.81	98.33	0.001680	1.34	14.88	21.68	0.29
Reach-1	10.2*	30.00	97.20	98.45	97.93	98.49	0.002174	1.65	18.21	23.68	0.33
Reach-1	10.2*	40.00	97.20	98.56	98.04	98.62	0.002570	1.91	20.99	24.85	0.37
Reach-1	10.2*	50.00	97.20	98.67	98.13	98.74	0.002873	2.12	23.61	25.90	0.39
Reach-1	10.2*	60.00	97.20	98.76	98.21	98.84	0.003119	2.30	26.08	26.85	0.41
Reach-1	10.2*	70.00	97.20	98.84	98.30	98.94	0.003348	2.47	28.38	27.72	0.43
Reach-1	10.2*	80.00	97.20	98.92	98.38	99.02	0.003651	2.63	30.47	28.92	0.45
Reach-1	10.2*	90.00	97.20	98.99	98.44	99.11	0.003922	2.77	32.50	30.03	0.47
Reach-1	10.2*	100.00	97.20	99.06	98.50	99.19	0.003911	2.87	34.90	30.52	0.47
Reach-1	10.2*	200.00	97.20	99.74	99.01	99.94	0.003476	3.57	56.05	31.71	0.47
Reach-1	10.2*	500.00	97.20	101.01	99.96	101.27	0.002642	4.41	190.62	227.13	0.45
Reach-1	10.2*	750.00	97.20	101.47	100.97	101.74	0.002666	4.86	315.40	319.57	0.46
Reach-1	10.2*	1000.00	97.20	101.80	101.35	102.08	0.002680	5.19	433.56	387.27	0.47
Reach-1	10.2*	1500.00	97.20	102.27	101.81	102.53	0.002663	5.58	618.98	401.75	0.48
Reach-1	10	10.00	97.50	97.94	97.94	98.05	0.029137	2.65	3.77	17.00	0.99
Reach-1	10	20.00	97.50	98.08	98.08	98.23	0.026329	3.13	6.39	20.86	1.00
Reach-1	10	30.00	97.50	98.18	98.18	98.37	0.025232	3.49	8.59	22.98	1.01
Reach-1	10	40.00	97.50	98.27	98.27	98.49	0.022938	3.74	10.70	24.04	0.99
Reach-1	10	50.00	97.50	98.34	98.34	98.59	0.022630	4.03	12.42	24.69	1.00
Reach-1	10	60.00	97.50	98.40	98.40	98.69	0.022469	4.28	14.02	25.28	1.01
Reach-1	10	70.00	97.50	98.47	98.47	98.78	0.021648	4.46	15.70	25.89	1.01
Reach-1	10	80.00	97.50	98.56	98.53	98.86	0.018907	4.42	18.09	27.23	0.96

Reach-1	10	90.00	97.50	98.70	98.60	98.96	0.013351	4.08	22.04	28.74	0.82
Reach-1	10	100.00	97.50	98.83	98.65	99.06	0.009920	3.88	25.79	28.97	0.72
Reach-1	10	200.00	97.50	99.58	99.08	99.85	0.005469	4.17	48.01	30.27	0.58
Reach-1	10	500.00	97.50	100.88	100.05	101.21	0.003545	4.91	166.67	209.44	0.51
Reach-1	10	750.00	97.50	101.36	101.02	101.68	0.003317	5.27	290.56	306.78	0.51
Reach-1	10	1000.00	97.50	101.72	101.36	102.02	0.003117	5.47	414.14	379.78	0.50
Reach-1	10	1500.00	97.50	102.19	101.89	102.47	0.002988	5.81	601.44	401.00	0.50

Design Channel: Bankfull Discharge = 200 cfs; Slope = 0.0031 ft/ft

Profile Output Table - Standard Table 1
HEC-RAS Plan: q200sp31int River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 659
Plans = 1
Profiles = 15

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	20	10.00	100.68	101.22	101.13	101.27	0.009971	1.81	5.53	19.82	0.60
Reach-1	20	20.00	100.68	101.40	101.26	101.47	0.008928	2.15	9.30	23.66	0.60
Reach-1	20	30.00	100.68	101.54	101.36	101.62	0.007668	2.35	12.78	25.36	0.58
Reach-1	20	40.00	100.68	101.66	101.45	101.76	0.006818	2.49	16.07	26.71	0.57
Reach-1	20	50.00	100.68	101.78	101.52	101.89	0.006003	2.58	19.36	27.61	0.54
Reach-1	20	60.00	100.68	101.90	101.59	102.01	0.005307	2.67	22.51	27.82	0.52
Reach-1	20	70.00	100.68	102.01	101.65	102.12	0.004813	2.74	25.54	28.01	0.51
Reach-1	20	80.00	100.68	102.11	101.71	102.23	0.004493	2.82	28.36	28.19	0.50
Reach-1	20	90.00	100.68	102.20	101.77	102.33	0.004241	2.90	31.08	28.37	0.49
Reach-1	20	100.00	100.68	102.29	101.82	102.43	0.004064	2.97	33.65	28.53	0.48
Reach-1	20	200.00	100.68	103.02	102.26	103.22	0.003500	3.65	54.77	29.85	0.48
Reach-1	20	500.00	100.68	104.07	103.50	104.37	0.003353	4.82	181.41	226.37	0.50
Reach-1	20	750.00	100.68	104.51	104.18	104.82	0.003285	5.25	301.67	316.25	0.51
Reach-1	20	1000.00	100.68	104.85	104.51	105.14	0.003184	5.51	419.46	384.42	0.51
Reach-1	20	1500.00	100.68	105.30	105.01	105.58	0.003109	5.88	598.83	400.00	0.51
Reach-1	19.8*	10.00	100.42	100.95	100.89	101.04	0.015017	2.30	4.35	14.81	0.75
Reach-1	19.8*	20.00	100.42	101.18	101.05	101.27	0.010437	2.48	8.05	18.50	0.66
Reach-1	19.8*	30.00	100.42	101.36	101.17	101.46	0.008338	2.53	11.87	22.43	0.61
Reach-1	19.8*	40.00	100.42	101.52	101.28	101.62	0.006603	2.56	15.63	24.26	0.56
Reach-1	19.8*	50.00	100.42	101.66	101.36	101.77	0.005693	2.61	19.18	25.88	0.53
Reach-1	19.8*	60.00	100.42	101.79	101.44	101.90	0.005090	2.65	22.64	27.35	0.51
Reach-1	19.8*	70.00	100.42	101.91	101.51	102.03	0.004619	2.69	25.99	28.46	0.50
Reach-1	19.8*	80.00	100.42	102.02	101.57	102.14	0.004188	2.75	29.12	28.66	0.48
Reach-1	19.8*	90.00	100.42	102.13	101.64	102.25	0.003888	2.81	32.08	28.84	0.47
Reach-1	19.8*	100.00	100.42	102.22	101.69	102.35	0.003694	2.87	34.82	29.02	0.46
Reach-1	19.8*	200.00	100.42	102.96	102.15	103.15	0.003168	3.52	56.74	30.35	0.45
Reach-1	19.8*	500.00	100.42	104.01	103.25	104.30	0.003141	4.71	184.43	227.62	0.49
Reach-1	19.8*	750.00	100.42	104.45	104.09	104.75	0.003151	5.18	303.39	316.45	0.50
Reach-1	19.8*	1000.00	100.42	104.79	104.42	105.08	0.003068	5.45	421.87	385.07	0.50
Reach-1	19.8*	1500.00	100.42	105.23	104.94	105.51	0.003048	5.86	599.33	400.16	0.51
Reach-1	19.6*	10.00	100.16	100.80	100.62	100.85	0.005965	1.77	5.64	14.11	0.49
Reach-1	19.6*	20.00	100.16	101.06	100.79	101.12	0.005091	2.08	9.61	16.74	0.48
Reach-1	19.6*	30.00	100.16	101.25	100.92	101.33	0.004805	2.30	13.05	18.68	0.48
Reach-1	19.6*	40.00	100.16	101.42	101.04	101.51	0.004840	2.44	16.40	21.55	0.49
Reach-1	19.6*	50.00	100.16	101.57	101.14	101.67	0.004571	2.52	19.82	23.70	0.49
Reach-1	19.6*	60.00	100.16	101.70	101.23	101.81	0.004268	2.59	23.19	25.31	0.48
Reach-1	19.6*	70.00	100.16	101.83	101.32	101.94	0.004037	2.64	26.47	26.79	0.47
Reach-1	19.6*	80.00	100.16	101.95	101.40	102.06	0.003868	2.70	29.64	28.14	0.46

Reach-1	19.6*	90.00	100.16	102.05	101.48	102.17	0.003704	2.75	32.75	29.26	0.46
Reach-1	19.6*	100.00	100.16	102.15	101.54	102.28	0.003479	2.80	35.68	29.45	0.45
Reach-1	19.6*	200.00	100.16	102.91	102.07	103.09	0.002947	3.43	58.37	30.88	0.44
Reach-1	19.6*	500.00	100.16	103.96	103.07	104.23	0.002926	4.58	190.44	231.58	0.47
Reach-1	19.6*	750.00	100.16	104.39	103.99	104.68	0.002983	5.06	309.56	319.14	0.49
Reach-1	19.6*	1000.00	100.16	104.73	104.33	105.01	0.002918	5.34	429.23	387.68	0.49
Reach-1	19.6*	1500.00	100.16	105.17	104.86	105.45	0.002939	5.77	605.21	400.34	0.50
Reach-1	19.4*	10.00	99.90	100.76	100.34	100.79	0.001487	1.15	8.68	14.48	0.26
Reach-1	19.4*	20.00	99.90	101.01	100.52	101.05	0.002079	1.60	12.51	16.34	0.32
Reach-1	19.4*	30.00	99.90	101.20	100.66	101.26	0.002459	1.91	15.70	17.74	0.36
Reach-1	19.4*	40.00	99.90	101.36	100.79	101.43	0.002698	2.15	18.64	18.93	0.38
Reach-1	19.4*	50.00	99.90	101.50	100.89	101.59	0.003024	2.33	21.50	21.05	0.41
Reach-1	19.4*	60.00	99.90	101.64	100.99	101.73	0.003221	2.45	24.47	23.21	0.42
Reach-1	19.4*	70.00	99.90	101.76	101.08	101.86	0.003248	2.55	27.48	24.76	0.43
Reach-1	19.4*	80.00	99.90	101.88	101.16	101.99	0.003263	2.63	30.41	26.17	0.43
Reach-1	19.4*	90.00	99.90	101.99	101.24	102.10	0.003255	2.70	33.33	27.51	0.43
Reach-1	19.4*	100.00	99.90	102.09	101.31	102.21	0.003243	2.76	36.18	28.75	0.43
Reach-1	19.4*	200.00	99.90	102.85	101.94	103.03	0.002835	3.36	59.50	31.38	0.43
Reach-1	19.4*	500.00	99.90	103.91	102.96	104.17	0.002810	4.48	194.19	234.29	0.46
Reach-1	19.4*	750.00	99.90	104.34	103.92	104.62	0.002896	4.98	313.17	321.16	0.48
Reach-1	19.4*	1000.00	99.90	104.68	104.26	104.95	0.002835	5.26	434.01	390.06	0.48
Reach-1	19.4*	1500.00	99.90	105.12	104.80	105.39	0.002875	5.70	609.15	400.50	0.49
Reach-1	19.2*	10.00	99.64	100.75	100.07	100.77	0.000551	0.85	11.83	14.70	0.17
Reach-1	19.2*	20.00	99.64	100.99	100.25	101.02	0.001011	1.29	15.54	16.12	0.23
Reach-1	19.2*	30.00	99.64	101.18	100.40	101.22	0.001385	1.62	18.56	17.25	0.27
Reach-1	19.2*	40.00	99.64	101.33	100.53	101.39	0.001677	1.88	21.31	18.22	0.31
Reach-1	19.2*	50.00	99.64	101.47	100.64	101.54	0.001913	2.09	23.87	19.09	0.33
Reach-1	19.2*	60.00	99.64	101.59	100.75	101.68	0.002207	2.27	26.39	20.76	0.36
Reach-1	19.2*	70.00	99.64	101.71	100.85	101.81	0.002459	2.41	28.99	22.63	0.38
Reach-1	19.2*	80.00	99.64	101.83	100.93	101.93	0.002630	2.53	31.60	24.17	0.39
Reach-1	19.2*	90.00	99.64	101.93	101.02	102.04	0.002739	2.63	34.23	25.51	0.40
Reach-1	19.2*	100.00	99.64	102.03	101.10	102.15	0.002826	2.72	36.82	26.76	0.41
Reach-1	19.2*	200.00	99.64	102.80	101.79	102.97	0.002829	3.33	60.04	31.87	0.43
Reach-1	19.2*	500.00	99.64	103.86	102.90	104.11	0.002756	4.42	197.13	236.45	0.45
Reach-1	19.2*	750.00	99.64	104.28	103.85	104.55	0.002855	4.92	315.88	322.53	0.47
Reach-1	19.2*	1000.00	99.64	104.63	104.19	104.89	0.002789	5.19	437.71	391.64	0.47
Reach-1	19.2*	1500.00	99.64	105.06	104.73	105.33	0.002840	5.64	612.16	400.66	0.49
Reach-1	19.*	10.00	99.38	100.75	99.80	100.76	0.000263	0.67	14.94	14.82	0.12
Reach-1	19.*	20.00	99.38	100.99	99.99	101.00	0.000568	1.06	18.57	16.01	0.18
Reach-1	19.*	30.00	99.38	101.16	100.14	101.19	0.000853	1.40	21.47	16.95	0.22
Reach-1	19.*	40.00	99.38	101.31	100.28	101.35	0.001104	1.66	24.08	17.77	0.25
Reach-1	19.*	50.00	99.38	101.45	100.40	101.50	0.001326	1.89	26.50	18.49	0.28
Reach-1	19.*	60.00	99.38	101.57	100.51	101.64	0.001520	2.08	28.80	19.15	0.30
Reach-1	19.*	70.00	99.38	101.68	100.61	101.76	0.001751	2.25	31.05	20.41	0.32
Reach-1	19.*	80.00	99.38	101.79	100.70	101.88	0.001990	2.40	33.29	21.91	0.34
Reach-1	19.*	90.00	99.38	101.89	100.79	101.99	0.002193	2.53	35.58	23.35	0.36
Reach-1	19.*	100.00	99.38	101.98	100.87	102.09	0.002358	2.64	37.87	24.63	0.38
Reach-1	19.*	200.00	99.38	102.74	101.56	102.91	0.002923	3.33	60.01	32.34	0.43
Reach-1	19.*	500.00	99.38	103.81	102.87	104.05	0.002706	4.33	202.26	240.79	0.45
Reach-1	19.*	750.00	99.38	104.24	103.78	104.49	0.002794	4.82	322.40	326.32	0.46
Reach-1	19.*	1000.00	99.38	104.58	104.09	104.83	0.002717	5.07	446.14	395.53	0.47
Reach-1	19.*	1500.00	99.38	105.01	104.65	105.26	0.002768	5.52	620.21	400.84	0.48
Reach-1	18.8	10.00	99.12	100.75	99.53	100.75	0.000150	0.56	17.82	14.81	0.09
Reach-1	18.8	20.00	99.12	100.98	99.73	100.99	0.000360	0.94	21.38	15.85	0.14
Reach-1	18.8	30.00	99.12	101.15	99.89	101.18	0.000578	1.24	24.18	16.67	0.18
Reach-1	18.8	40.00	99.12	101.30	100.03	101.33	0.000784	1.50	26.69	17.38	0.21

Reach-1	18.8	50.00	99.12	101.43	100.15	101.48	0.000978	1.72	28.99	18.02	0.24
Reach-1	18.8	60.00	99.12	101.55	100.26	101.61	0.001156	1.92	31.17	18.59	0.26
Reach-1	18.8	70.00	99.12	101.66	100.37	101.73	0.001319	2.10	33.26	19.13	0.28
Reach-1	18.8	80.00	99.12	101.76	100.47	101.84	0.001505	2.27	35.23	19.97	0.30
Reach-1	18.8	90.00	99.12	101.86	100.56	101.95	0.001721	2.42	37.21	21.28	0.32
Reach-1	18.8	100.00	99.12	101.95	100.65	102.05	0.001921	2.55	39.20	22.51	0.34
Reach-1	18.8	200.00	99.12	102.68	101.38	102.85	0.003114	3.38	59.19	32.39	0.44
Reach-1	18.8	500.00	99.12	103.76	102.91	104.00	0.002749	4.30	204.27	243.26	0.45
Reach-1	18.8	750.00	99.12	104.18	103.72	104.43	0.002812	4.77	325.45	328.92	0.46
Reach-1	18.8	1000.00	99.12	104.53	104.05	104.77	0.002702	4.99	451.36	397.93	0.46
Reach-1	18.8	1500.00	99.12	104.96	104.49	105.21	0.002740	5.42	625.67	401.00	0.47
Reach-1	18.6*	10.00	99.36	100.74	99.78	100.75	0.000243	0.64	15.54	15.54	0.11
Reach-1	18.6*	20.00	99.36	100.97	99.97	100.98	0.000538	1.04	19.18	16.80	0.17
Reach-1	18.6*	30.00	99.36	101.13	100.12	101.16	0.000823	1.36	22.04	17.77	0.22
Reach-1	18.6*	40.00	99.36	101.27	100.25	101.32	0.001080	1.63	24.61	18.60	0.25
Reach-1	18.6*	50.00	99.36	101.40	100.37	101.45	0.001312	1.85	26.98	19.33	0.28
Reach-1	18.6*	60.00	99.36	101.51	100.47	101.58	0.001605	2.05	29.28	21.02	0.31
Reach-1	18.6*	70.00	99.36	101.62	100.57	101.70	0.001861	2.21	31.61	22.61	0.33
Reach-1	18.6*	80.00	99.36	101.72	100.66	101.80	0.002083	2.36	33.90	23.99	0.35
Reach-1	18.6*	90.00	99.36	101.81	100.75	101.91	0.002260	2.49	36.20	25.20	0.37
Reach-1	18.6*	100.00	99.36	101.90	100.83	102.00	0.002414	2.60	38.48	26.34	0.38
Reach-1	18.6*	200.00	99.36	102.62	101.54	102.79	0.002858	3.33	60.14	32.12	0.43
Reach-1	18.6*	500.00	99.36	103.70	102.73	103.94	0.002611	4.30	205.59	243.75	0.44
Reach-1	18.6*	750.00	99.36	104.12	103.66	104.38	0.002733	4.81	325.23	328.43	0.46
Reach-1	18.6*	1000.00	99.36	104.46	104.00	104.71	0.002692	5.08	447.24	396.59	0.47
Reach-1	18.6*	1500.00	99.36	104.90	104.53	105.15	0.002720	5.51	623.47	400.75	0.48
Reach-1	18.4*	10.00	99.60	100.73	100.04	100.74	0.000485	0.78	12.82	16.49	0.16
Reach-1	18.4*	20.00	99.60	100.95	100.22	100.97	0.000945	1.21	16.53	18.09	0.22
Reach-1	18.4*	30.00	99.60	101.10	100.36	101.14	0.001360	1.54	19.45	19.37	0.27
Reach-1	18.4*	40.00	99.60	101.24	100.49	101.29	0.001813	1.80	22.19	21.69	0.31
Reach-1	18.4*	50.00	99.60	101.36	100.59	101.42	0.002152	2.01	24.90	23.54	0.34
Reach-1	18.4*	60.00	99.60	101.46	100.69	101.54	0.002385	2.18	27.55	24.89	0.36
Reach-1	18.4*	70.00	99.60	101.57	100.78	101.65	0.002558	2.32	30.19	26.16	0.38
Reach-1	18.4*	80.00	99.60	101.66	100.86	101.76	0.002705	2.44	32.74	27.33	0.39
Reach-1	18.4*	90.00	99.60	101.76	100.94	101.86	0.002811	2.55	35.30	28.45	0.40
Reach-1	18.4*	100.00	99.60	101.84	101.02	101.95	0.002888	2.64	37.83	29.46	0.41
Reach-1	18.4*	200.00	99.60	102.56	101.64	102.73	0.002793	3.34	59.80	31.42	0.43
Reach-1	18.4*	500.00	99.60	103.64	102.67	103.89	0.002633	4.37	203.03	241.69	0.45
Reach-1	18.4*	750.00	99.60	104.06	103.61	104.32	0.002755	4.89	322.51	326.71	0.47
Reach-1	18.4*	1000.00	99.60	104.39	103.95	104.65	0.002751	5.19	441.09	393.32	0.47
Reach-1	18.4*	1500.00	99.60	104.83	104.49	105.09	0.002770	5.62	618.20	400.50	0.48
Reach-1	18.2*	10.00	99.83	100.71	100.30	100.73	0.001340	1.03	9.75	18.07	0.25
Reach-1	18.2*	20.00	99.83	100.91	100.46	100.94	0.002228	1.46	13.65	21.64	0.33
Reach-1	18.2*	30.00	99.83	101.05	100.59	101.10	0.002737	1.77	16.96	23.60	0.37
Reach-1	18.2*	40.00	99.83	101.18	100.70	101.24	0.003049	2.00	19.99	25.03	0.39
Reach-1	18.2*	50.00	99.83	101.29	100.80	101.36	0.003240	2.18	22.91	26.33	0.41
Reach-1	18.2*	60.00	99.83	101.40	100.89	101.48	0.003350	2.33	25.78	27.55	0.42
Reach-1	18.2*	70.00	99.83	101.50	100.97	101.59	0.003389	2.44	28.66	28.72	0.43
Reach-1	18.2*	80.00	99.83	101.60	101.04	101.70	0.003311	2.55	31.42	28.99	0.43
Reach-1	18.2*	90.00	99.83	101.69	101.10	101.80	0.003227	2.64	34.10	29.16	0.43
Reach-1	18.2*	100.00	99.83	101.77	101.16	101.89	0.003166	2.73	36.65	29.32	0.43
Reach-1	18.2*	200.00	99.83	102.49	101.64	102.68	0.002957	3.44	58.14	30.64	0.44
Reach-1	18.2*	500.00	99.83	103.56	102.67	103.83	0.002855	4.54	194.53	235.80	0.47
Reach-1	18.2*	750.00	99.83	103.98	103.59	104.27	0.002959	5.05	312.30	321.60	0.48
Reach-1	18.2*	1000.00	99.83	104.32	103.92	104.60	0.002913	5.34	431.16	389.48	0.49
Reach-1	18.2*	1500.00	99.83	104.76	104.44	105.03	0.002918	5.76	607.92	400.25	0.50

Reach-1	18	10.00	100.07	100.62	100.52	100.67	0.009466	1.78	5.63	19.93	0.59
Reach-1	18	20.00	100.07	100.79	100.65	100.86	0.008914	2.15	9.31	23.67	0.60
Reach-1	18	30.00	100.07	100.93	100.75	101.01	0.007691	2.35	12.76	25.35	0.58
Reach-1	18	40.00	100.07	101.05	100.84	101.15	0.006874	2.50	16.03	26.70	0.57
Reach-1	18	50.00	100.07	101.17	100.91	101.28	0.006068	2.59	19.30	27.60	0.55
Reach-1	18	60.00	100.07	101.28	100.98	101.40	0.005375	2.68	22.43	27.81	0.53
Reach-1	18	70.00	100.07	101.39	101.04	101.51	0.004876	2.75	25.43	28.01	0.51
Reach-1	18	80.00	100.07	101.49	101.10	101.62	0.004550	2.83	28.24	28.19	0.50
Reach-1	18	90.00	100.07	101.59	101.16	101.72	0.004291	2.91	30.96	28.36	0.49
Reach-1	18	100.00	100.07	101.68	101.21	101.82	0.004112	2.98	33.52	28.53	0.48
Reach-1	18	200.00	100.07	102.40	101.65	102.61	0.003530	3.66	54.62	29.84	0.48
Reach-1	18	500.00	100.07	103.46	102.89	103.76	0.003367	4.82	180.94	225.94	0.50
Reach-1	18	750.00	100.07	103.90	103.57	104.21	0.003275	5.24	302.21	316.59	0.51
Reach-1	18	1000.00	100.07	104.23	103.90	104.53	0.003218	5.53	417.13	383.20	0.51
Reach-1	18	1500.00	100.07	104.69	104.40	104.97	0.003106	5.88	599.05	400.00	0.51
Reach-1	17.8*	10.00	99.81	100.34	100.28	100.43	0.015247	2.31	4.33	14.78	0.75
Reach-1	17.8*	20.00	99.81	100.56	100.44	100.66	0.010648	2.50	7.99	18.42	0.67
Reach-1	17.8*	30.00	99.81	100.75	100.56	100.85	0.008533	2.55	11.78	22.38	0.62
Reach-1	17.8*	40.00	99.81	100.91	100.67	101.01	0.006745	2.58	15.51	24.21	0.57
Reach-1	17.8*	50.00	99.81	101.05	100.75	101.16	0.005800	2.62	19.06	25.82	0.54
Reach-1	17.8*	60.00	99.81	101.18	100.83	101.29	0.005182	2.67	22.50	27.29	0.52
Reach-1	17.8*	70.00	99.81	101.30	100.90	101.41	0.004709	2.71	25.84	28.45	0.50
Reach-1	17.8*	80.00	99.81	101.41	100.96	101.53	0.004262	2.76	28.96	28.65	0.48
Reach-1	17.8*	90.00	99.81	101.51	101.03	101.63	0.003948	2.82	31.93	28.84	0.47
Reach-1	17.8*	100.00	99.81	101.61	101.08	101.74	0.003749	2.88	34.66	29.01	0.47
Reach-1	17.8*	200.00	99.81	102.34	101.54	102.54	0.003198	3.54	56.57	30.34	0.46
Reach-1	17.8*	500.00	99.81	103.40	102.64	103.69	0.003162	4.72	183.46	226.46	0.49
Reach-1	17.8*	750.00	99.81	103.84	103.48	104.14	0.003155	5.18	302.89	315.72	0.50
Reach-1	17.8*	1000.00	99.81	104.17	103.81	104.46	0.003124	5.49	417.54	382.27	0.50
Reach-1	17.8*	1500.00	99.81	104.62	104.33	104.90	0.003072	5.88	597.32	400.16	0.51
Reach-1	17.6*	10.00	99.55	100.18	100.02	100.23	0.006556	1.83	5.46	13.93	0.52
Reach-1	17.6*	20.00	99.55	100.44	100.18	100.51	0.005388	2.13	9.41	16.55	0.50
Reach-1	17.6*	30.00	99.55	100.63	100.32	100.71	0.005035	2.34	12.82	18.51	0.50
Reach-1	17.6*	40.00	99.55	100.80	100.43	100.89	0.005039	2.48	16.13	21.31	0.50
Reach-1	17.6*	50.00	99.55	100.95	100.53	101.05	0.004765	2.56	19.54	23.59	0.50
Reach-1	17.6*	60.00	99.55	101.09	100.62	101.19	0.004424	2.62	22.90	25.21	0.48
Reach-1	17.6*	70.00	99.55	101.21	100.71	101.32	0.004172	2.67	26.17	26.68	0.48
Reach-1	17.6*	80.00	99.55	101.33	100.80	101.44	0.003983	2.73	29.34	28.04	0.47
Reach-1	17.6*	90.00	99.55	101.44	100.87	101.56	0.003814	2.77	32.45	29.24	0.46
Reach-1	17.6*	100.00	99.55	101.54	100.94	101.66	0.003573	2.83	35.38	29.43	0.45
Reach-1	17.6*	200.00	99.55	102.29	101.46	102.47	0.002994	3.44	58.08	30.85	0.44
Reach-1	17.6*	500.00	99.55	103.34	102.44	103.62	0.003007	4.62	186.59	228.29	0.48
Reach-1	17.6*	750.00	99.55	103.78	103.39	104.07	0.003050	5.11	305.31	316.71	0.49
Reach-1	17.6*	1000.00	99.55	104.11	103.73	104.40	0.003028	5.42	420.72	383.60	0.50
Reach-1	17.6*	1500.00	99.55	104.55	104.26	104.84	0.003017	5.84	598.84	400.34	0.51
Reach-1	17.4*	10.00	99.29	100.14	99.74	100.16	0.001669	1.20	8.34	14.28	0.28
Reach-1	17.4*	20.00	99.29	100.39	99.92	100.43	0.002250	1.65	12.16	16.15	0.33
Reach-1	17.4*	30.00	99.29	100.58	100.06	100.64	0.002626	1.96	15.33	17.57	0.37
Reach-1	17.4*	40.00	99.29	100.74	100.18	100.81	0.002859	2.19	18.26	18.76	0.39
Reach-1	17.4*	50.00	99.29	100.88	100.29	100.97	0.003168	2.37	21.07	20.74	0.41
Reach-1	17.4*	60.00	99.29	101.02	100.39	101.11	0.003398	2.50	24.01	23.05	0.43
Reach-1	17.4*	70.00	99.29	101.14	100.48	101.25	0.003411	2.59	27.01	24.59	0.44
Reach-1	17.4*	80.00	99.29	101.26	100.56	101.37	0.003410	2.67	29.94	26.02	0.44
Reach-1	17.4*	90.00	99.29	101.37	100.64	101.48	0.003389	2.74	32.86	27.36	0.44
Reach-1	17.4*	100.00	99.29	101.47	100.71	101.59	0.003363	2.80	35.71	28.59	0.44
Reach-1	17.4*	200.00	99.29	102.23	101.34	102.41	0.002905	3.39	59.03	31.34	0.44
Reach-1	17.4*	500.00	99.29	103.29	102.36	103.56	0.002913	4.55	189.49	230.40	0.47

Reach-1	17.4*	750.00	99.29	103.72	103.31	104.01	0.002981	5.04	307.95	318.21	0.48
Reach-1	17.4*	1000.00	99.29	104.05	103.66	104.34	0.002958	5.35	424.43	385.53	0.49
Reach-1	17.4*	1500.00	99.29	104.49	104.19	104.77	0.002968	5.78	601.53	400.50	0.50
Reach-1	17.2*	10.00	99.04	100.13	99.47	100.14	0.000603	0.87	11.47	14.57	0.17
Reach-1	17.2*	20.00	99.04	100.37	99.65	100.40	0.001082	1.32	15.19	16.03	0.24
Reach-1	17.2*	30.00	99.04	100.55	99.80	100.59	0.001465	1.65	18.19	17.13	0.28
Reach-1	17.2*	40.00	99.04	100.71	99.93	100.76	0.001760	1.91	20.94	18.09	0.31
Reach-1	17.2*	50.00	99.04	100.84	100.04	100.91	0.001998	2.13	23.49	18.94	0.34
Reach-1	17.2*	60.00	99.04	100.97	100.15	101.05	0.002274	2.31	25.96	20.39	0.36
Reach-1	17.2*	70.00	99.04	101.09	100.24	101.18	0.002540	2.45	28.52	22.26	0.38
Reach-1	17.2*	80.00	99.04	101.20	100.33	101.31	0.002729	2.57	31.10	23.88	0.40
Reach-1	17.2*	90.00	99.04	101.31	100.42	101.42	0.002843	2.67	33.72	25.26	0.41
Reach-1	17.2*	100.00	99.04	101.41	100.50	101.53	0.002932	2.75	36.30	26.54	0.42
Reach-1	17.2*	200.00	99.04	102.18	101.19	102.35	0.002910	3.36	59.51	31.84	0.43
Reach-1	17.2*	500.00	99.04	103.24	102.30	103.50	0.002829	4.46	194.12	233.72	0.46
Reach-1	17.2*	750.00	99.04	103.67	103.24	103.94	0.002903	4.95	313.16	320.51	0.48
Reach-1	17.2*	1000.00	99.04	104.00	103.58	104.27	0.002877	5.25	430.83	387.66	0.48
Reach-1	17.2*	1500.00	99.04	104.44	104.12	104.71	0.002909	5.69	606.67	400.66	0.49
Reach-1	17.*	10.00	98.78	100.12	99.20	100.13	0.000285	0.69	14.51	14.68	0.12
Reach-1	17.*	20.00	98.78	100.36	99.39	100.38	0.000606	1.10	18.14	15.88	0.18
Reach-1	17.*	30.00	98.78	100.54	99.54	100.57	0.000904	1.43	21.03	16.81	0.22
Reach-1	17.*	40.00	98.78	100.69	99.68	100.73	0.001164	1.69	23.63	17.63	0.26
Reach-1	17.*	50.00	98.78	100.82	99.80	100.88	0.001393	1.92	26.04	18.35	0.28
Reach-1	17.*	60.00	98.78	100.94	99.91	101.01	0.001592	2.12	28.32	19.01	0.31
Reach-1	17.*	70.00	98.78	101.06	100.01	101.14	0.001811	2.29	30.54	20.07	0.33
Reach-1	17.*	80.00	98.78	101.16	100.10	101.25	0.002067	2.44	32.74	21.62	0.35
Reach-1	17.*	90.00	98.78	101.26	100.19	101.37	0.002282	2.57	35.01	23.11	0.37
Reach-1	17.*	100.00	98.78	101.36	100.27	101.47	0.002454	2.68	37.28	24.41	0.38
Reach-1	17.*	200.00	98.78	102.12	100.96	102.29	0.003029	3.37	59.29	32.25	0.44
Reach-1	17.*	500.00	98.78	103.18	102.27	103.44	0.002840	4.41	196.08	235.81	0.46
Reach-1	17.*	750.00	98.78	103.61	103.18	103.88	0.002902	4.89	315.73	322.56	0.47
Reach-1	17.*	1000.00	98.78	103.95	103.52	104.21	0.002855	5.17	435.00	390.29	0.48
Reach-1	17.*	1500.00	98.78	104.39	104.05	104.65	0.002882	5.61	610.67	400.84	0.49
Reach-1	16.8	10.00	98.52	100.12	98.93	100.12	0.000161	0.57	17.40	14.68	0.09
Reach-1	16.8	20.00	98.52	100.35	99.13	100.37	0.000381	0.95	20.95	15.73	0.15
Reach-1	16.8	30.00	98.52	100.53	99.29	100.55	0.000608	1.26	23.74	16.54	0.19
Reach-1	16.8	40.00	98.52	100.67	99.43	100.71	0.000822	1.52	26.23	17.26	0.22
Reach-1	16.8	50.00	98.52	100.80	99.55	100.85	0.001022	1.75	28.52	17.89	0.24
Reach-1	16.8	60.00	98.52	100.92	99.66	100.98	0.001206	1.96	30.68	18.47	0.27
Reach-1	16.8	70.00	98.52	101.03	99.77	101.10	0.001374	2.14	32.76	19.00	0.29
Reach-1	16.8	80.00	98.52	101.13	99.87	101.22	0.001546	2.30	34.71	19.62	0.31
Reach-1	16.8	90.00	98.52	101.23	99.96	101.32	0.001771	2.46	36.66	20.92	0.33
Reach-1	16.8	100.00	98.52	101.32	100.05	101.42	0.001979	2.59	38.61	22.15	0.35
Reach-1	16.8	200.00	98.52	102.05	100.78	102.23	0.003224	3.43	58.31	32.02	0.45
Reach-1	16.8	500.00	98.52	103.13	102.31	103.38	0.002925	4.40	196.38	236.61	0.46
Reach-1	16.8	750.00	98.52	103.56	103.12	103.82	0.002956	4 86	316.55	323.40	0.47
Reach-1	16.8	1000.00	98.52	103.89	103.45	104.15	0.002877	5.12	437.29	391.69	0.47
Reach-1	16.8	1500.00	98.52	104.33	103.89	104.59	0.002888	5.53	613.15	401.00	0.48
Reach-1	16.6*	10.00	98.75	100.11	99.17	100.12	0.000258	0.66	15.22	15.44	0.12
Reach-1	16.6*	20.00	98.75	100.34	99.36	100.36	0.000564	1.06	18.86	16.69	0.18
Reach-1	16.6*	30.00	98.75	100.51	99.51	100.54	0.000858	1.38	21.71	17.64	0.22
Reach-1	16.6*	40.00	98.75	100.65	99.65	100.69	0.001122	1.65	24.26	18.46	0.25
Reach-1	16.6*	50.00	98.75	100.77	99.76	100.83	0.001359	1.88	26.61	19.18	0.28
Reach-1	16.6*	60.00	98.75	100.89	99.87	100.95	0.001646	2.08	28.86	20.66	0.31
Reach-1	16.6*	70.00	98.75	100.99	99.96	101.07	0.001919	2.25	31.16	22.30	0.33
Reach-1	16.6*	80.00	98.75	101.09	100.06	101.18	0.002156	2.39	33.42	23.77	0.36

Reach-1	16.6*	90.00	98.75	101.18	100.14	101.28	0.002339	2.52	35.70	24.97	0.37
Reach-1	16.6*	100.00	98.75	101.27	100.23	101.38	0.002497	2.63	37.96	26.11	0.39
Reach-1	16.6*	200.00	98.75	101.99	100.93	102.17	0.002955	3.36	59.47	32.04	0.43
Reach-1	16.6*	500.00	98.75	103.07	102.12	103.32	0.002774	4.40	197.30	236.88	0.45
Reach-1	16.6*	750.00	98.75	103.48	103.05	103.76	0.002922	4.94	312.84	321.00	0.48
Reach-1	16.6*	1000.00	98.75	103.83	103.40	104.09	0.002826	5.19	435.79	391.12	0.48
Reach-1	16.6*	1500.00	98.75	104.26	103.93	104.53	0.002878	5.64	609.76	400.75	0.49
Reach-1	16.4*	10.00	98.98	100.10	99.42	100.11	0.000502	0.79	12.66	16.41	0.16
Reach-1	16.4*	20.00	98.98	100.32	99.60	100.34	0.000968	1.22	16.39	18.03	0.23
Reach-1	16.4*	30.00	98.98	100.48	99.74	100.51	0.001381	1.55	19.31	19.24	0.27
Reach-1	16.4*	40.00	98.98	100.61	99.87	100.66	0.001834	1.82	22.02	21.46	0.32
Reach-1	16.4*	50.00	98.98	100.73	99.97	100.79	0.002184	2.02	24.70	23.33	0.35
Reach-1	16.4*	60.00	98.98	100.84	100.07	100.91	0.002422	2.20	27.33	24.68	0.37
Reach-1	16.4*	70.00	98.98	100.94	100.16	101.03	0.002601	2.34	29.94	25.95	0.38
Reach-1	16.4*	80.00	98.98	101.04	100.24	101.13	0.002752	2.46	32.47	27.12	0.40
Reach-1	16.4*	90.00	98.98	101.13	100.32	101.23	0.002863	2.57	35.01	28.25	0.41
Reach-1	16.4*	100.00	98.98	101.22	100.40	101.33	0.002949	2.66	37.53	29.32	0.42
Reach-1	16.4*	200.00	98.98	101.93	101.02	102.11	0.002840	3.36	59.47	31.38	0.43
Reach-1	16.4*	500.00	98.98	103.00	102.04	103.26	0.002735	4.44	197.66	237.27	0.45
Reach-1	16.4*	750.00	98.98	103.42	103.00	103.70	0.002900	4.99	312.89	320.99	0.48
Reach-1	16.4*	1000.00	98.98	103.76	103.34	104.03	0.002825	5.25	434.77	390.46	0.48
Reach-1	16.4*	1500.00	98.98	104.20	103.88	104.47	0.002877	5.70	608.96	400.50	0.49
Reach-1	16.2*	10.00	99.21	100.08	99.68	100.10	0.001416	1.05	9.56	17.94	0.25
Reach-1	16.2*	20.00	99.21	100.28	99.84	100.31	0.002311	1.49	13.45	21.46	0.33
Reach-1	16.2*	30.00	99.21	100.42	99.97	100.47	0.002842	1.79	16.75	23.52	0.37
Reach-1	16.2*	40.00	99.21	100.55	100.08	100.61	0.003155	2.02	19.77	24.98	0.40
Reach-1	16.2*	50.00	99.21	100.66	100.18	100.74	0.003343	2.20	22.69	26.31	0.42
Reach-1	16.2*	60.00	99.21	100.77	100.27	100.85	0.003443	2.35	25.56	27.53	0.43
Reach-1	16.2*	70.00	99.21	100.87	100.35	100.97	0.003464	2.46	28.44	28.63	0.44
Reach-1	16.2*	80.00	99.21	100.97	100.42	101.07	0.003386	2.56	31.20	28.98	0.44
Reach-1	16.2*	90.00	99.21	101.06	100.48	101.17	0.003294	2.66	33.87	29.15	0.43
Reach-1	16.2*	100.00	99.21	101.15	100.54	101.26	0.003227	2.75	36.43	29.31	0.43
Reach-1	16.2*	200.00	99.21	101.86	101.02	102.05	0.002990	3.45	57.93	30.63	0.44
Reach-1	16.2*	500.00	99.21	102.93	102.06	103.20	0.002921	4.58	191.52	233.18	0.47
Reach-1	16.2*	750.00	99.21	103.35	102.97	103.64	0.003012	5.09	309.02	319.51	0.49
Reach-1	16.2*	1000.00	99.21	103.68	103.30	103.97	0.002976	5.38	426.26	386.91	0.49
Reach-1	16.2*	1500.00	99.21	104.12	103.82	104.40	0.002992	5.82	601.99	400.25	0.50
Reach-1	16	10.00	99.44	99.98	99.89	100.03	0.009958	1.81	5.53	19.82	0.60
Reach-1	16	20.00	99.44	100.16	100.02	100.23	0.008925	2.15	9.30	23.66	0.60
Reach-1	16	30.00	99.44	100.30	100.12	100.38	0.007672	2.35	12.78	25.36	0.58
Reach-1	16	40.00	99.44	100.42	100.21	100.52	0.006826	2.49	16.06	26.71	0.57
Reach-1	16	50.00	99.44	100.54	100.28	100.65	0.006012	2.58	19.35	27.61	0.54
Reach-1	16	60.00	99.44	100.66	100.35	100.77	0.005318	2.67	22.50	27.81	0.52
Reach-1	16	70.00	99.44	100.76	100.41	100.88	0.004826	2.74	25.52	28.01	0.51
Reach-1	16	80.00	99.44	100.87	100.47	100.99	0.004504	2.82	28.33	28.19	0.50
Reach-1	16	90.00	99.44	100.96	100.53	101.09	0.004250	2.90	31.06	28.37	0.49
Reach-1	16	100.00	99.44	101.05	100.58	101.19	0.004074	2.97	33.62	28.53	0.48
Reach-1	16	200.00	99.44	101.78	101.02	101.98	0.003503	3.65	54.75	29.85	0.48
Reach-1	16	500.00	99.44	102.83	102.26	103.13	0.003329	4.80	182.29	227.15	0.50
Reach-1	16	750.00	99.44	103.28	102.94	103.58	0.003257	5.23	303.12	317.18	0.51
Reach-1	16	1000.00	99.44	103.61	103.27	103.90	0.003170	5.50	420.44	384.94	0.51
Reach-1	16	1500.00	99.44	104.06	103.77	104.34	0.003086	5.86	600.53	400.00	0.51
Reach-1	15.8*	10.00	99.18	99.71	99.65	99.80	0.014955	2.29	4.36	14.81	0.74
Reach-1	15.8*	20.00	99.18	99.94	99.81	100.03	0.010484	2.49	8.04	18.48	0.66
Reach-1	15.8*	30.00	99.18	100.12	99.93	100.22	0.008377	2.53	11.85	22.42	0.61
Reach-1	15.8*	40.00	99.18	100.28	100.04	100.38	0.006625	2.56	15.61	24.25	0.56

Reach-1	15.8*	50.00	99.18	100.42	100.12	100.53	0.005708	2.61	19.16	25.87	0.53
Reach-1	15.8*	60.00	99.18	100.55	100.20	100.66	0.005105	2.65	22.61	27.34	0.51
Reach-1	15.8*	70.00	99.18	100.67	100.27	100.79	0.004636	2.70	25.96	28.46	0.50
Reach-1	15.8*	80.00	99.18	100.78	100.33	100.90	0.004202	2.75	29.09	28.66	0.48
Reach-1	15.8*	90.00	99.18	100.89	100.40	101.01	0.003899	2.81	32.05	28.84	0.47
Reach-1	15.8*	100.00	99.18	100.98	100.45	101.11	0.003705	2.87	34.79	29.01	0.46
Reach-1	15.8*	200.00	99.18	101.72	100.91	101.91	0.003171	3.53	56.73	30.35	0.45
Reach-1	15.8*	500.00	99.18	102.77	102.00	103.06	0.003121	4.70	185.07	227.90	0.48
Reach-1	15.8*	750.00	99.18	103.21	102.85	103.51	0.003133	5.17	304.09	316.48	0.50
Reach-1	15.8*	1000.00	99.18	103.55	103.18	103.84	0.003072	5.45	421.27	384.24	0.50
Reach-1	15.8*	1500.00	99.18	103.99	103.70	104.28	0.003047	5.86	599.26	400.16	0.51
Reach-1	15.6*	10.00	98.92	99.55	99.39	99.60	0.006157	1.79	5.57	14.01	0.50
Reach-1	15.6*	20.00	98.92	99.81	99.55	99.88	0.005210	2.10	9.52	16.62	0.49
Reach-1	15.6*	30.00	98.92	100.01	99.69	100.09	0.004903	2.32	12.94	18.57	0.49
Reach-1	15.6*	40.00	98.92	100.17	99.80	100.27	0.004938	2.46	16.27	21.44	0.50
Reach-1	15.6*	50.00	98.92	100.32	99.90	100.42	0.004666	2.54	19.69	23.67	0.49
Reach-1	15.6*	60.00	98.92	100.46	99.99	100.57	0.004344	2.60	23.06	25.28	0.48
Reach-1	15.6*	70.00	98.92	100.59	100.08	100.70	0.004102	2.66	26.33	26.75	0.47
Reach-1	15.6*	80.00	98.92	100.70	100.17	100.82	0.003923	2.71	29.50	28.10	0.47
Reach-1	15.6*	90.00	98.92	100.81	100.24	100.93	0.003753	2.76	32.62	29.25	0.46
Reach-1	15.6*	100.00	98.92	100.91	100.31	101.03	0.003521	2.81	35.54	29.44	0.45
Reach-1	15.6*	200.00	98.92	101.67	100.83	101.85	0.002965	3.43	58.26	30.86	0.44
Reach-1	15.6*	500.00	98.92	102.72	101.81	103.00	0.002962	4.60	188.50	229.98	0.47
Reach-1	15.6*	750.00	98.92	103.15	102.76	103.44	0.003025	5.09	306.76	317.64	0.49
Reach-1	15.6*	1000.00	98.92	103.49	103.10	103.77	0.002972	5.38	424.87	385.79	0.49
Reach-1	15.6*	1500.00	98.92	103.93	103.63	104.21	0.002986	5.81	601.28	400.34	0.50
Reach-1	15.4*	10.00	98.67	99.52	99.11	99.54	0.001621	1.19	8.43	14.35	0.27
Reach-1	15.4*	20.00	98.67	99.77	99.29	99.81	0.002215	1.64	12.23	16.20	0.33
Reach-1	15.4*	30.00	98.67	99.95	99.43	100.01	0.002592	1.95	15.41	17.62	0.37
Reach-1	15.4*	40.00	98.67	100.11	99.56	100.19	0.002826	2.18	18.34	18.81	0.39
Reach-1	15.4*	50.00	98.67	100.26	99.66	100.35	0.003144	2.36	21.17	20.86	0.41
Reach-1	15.4*	60.00	98.67	100.39	99.76	100.49	0.003362	2.49	24.12	23.13	0.43
Reach-1	15.4*	70.00	98.67	100.52	99.85	100.62	0.003376	2.58	27.13	24.68	0.43
Reach-1	15.4*	80.00	98.67	100.63	99.94	100.74	0.003377	2.66	30.06	26.10	0.44
Reach-1	15.4*	90.00	98.67	100.74	100.01	100.86	0.003358	2.73	32.98	27.44	0.44
Reach-1	15.4*	100.00	98.67	100.84	100.08	100.97	0.003334	2.79	35.84	28.66	0.44
Reach-1	15.4*	200.00	98.67	101.61	100.71	101.79	0.002883	3.38	59.18	31.35	0.43
Reach-1	15.4*	500.00	98.67	102.67	101.73	102.93	0.002870	4.52	191.30	231.71	0.47
Reach-1	15.4*	750.00	98.67	103.09	102.69	103.38	0.002964	5.03	308.80	318.34	0.48
Reach-1	15.4*	1000.00	98.67	103.43	103.03	103.71	0.002910	5.31	427.82	386.79	0.49
Reach-1	15.4*	1500.00	98.67	103.87	103.57	104.15	0.002953	5.77	602.64	400.50	0.50
Reach-1	15.2*	10.00	98.41	99.51	98.84	99.52	0.000582	0.86	11.62	14.63	0.17
Reach-1	15.2*	20.00	98.41	99.75	99.02	99.77	0.001056	1.31	15.32	16.07	0.24
Reach-1	15.2*	30.00	98.41	99.93	99.17	99.97	0.001435	1.64	18.33	17.18	0.28
Reach-1	15.2*	40.00	98.41	100.08	99.30	100.14	0.001728	1.90	21.07	18.14	0.31
Reach-1	15.2*	50.00	98.41	100.22	99.41	100.29	0.001965	2.12	23.63	18.99	0.33
Reach-1	15.2*	60.00	98.41	100.35	99.52	100.43	0.002247	2.30	26.12	20.51	0.36
Reach-1	15.2*	70.00	98.41	100.47	99.61	100.56	0.002508	2.44	28.69	22.37	0.38
Reach-1	15.2*	80.00	98.41	100.58	99.70	100.68	0.002693	2.56	31.28	23.98	0.39
Reach-1	15.2*	90.00	98.41	100.69	99.79	100.80	0.002806	2.65	33.90	25.35	0.40
Reach-1	15.2*	100.00	98.41	100.79	99.87	100.90	0.002895	2.74	36.49	26.63	0.41
Reach-1	15.2*	200.00	98.41	101.56	100.56	101.73	0.002877	3.35	59.73	31.86	0.43
Reach-1	15.2*	500.00	98.41	102.62	101.67	102.87	0.002773	4.42	196.69	235.93	0.46
Reach-1	15.2*	750.00	98.41	103.04	102.61	103.32	0.002873	4.93	315.06	321.71	0.47
Reach-1	15.2*	1000.00	98.41	103.38	102.96	103.65	0.002814	5.20	435.83	390.25	0.48
Reach-1	15.2*	1500.00	98.41	103.82	103.49	104.08	0.002874	5.66	609.50	400.66	0.49

Reach-1	15.*	10.00	98.15	99.50	98.57	99.51	0.000277	0.68	14.66	14.73	0.12
Reach-1	15.*	20.00	98.15	99.74	98.76	99.76	0.000593	1.09	18.27	15.92	0.18
Reach-1	15.*	30.00	98.15	99.91	98.91	99.94	0.000888	1.42	21.16	16.85	0.22
Reach-1	15.*	40.00	98.15	100.06	99.05	100.11	0.001145	1.68	23.77	17.67	0.26
Reach-1	15.*	50.00	98.15	100.20	99.17	100.25	0.001372	1.91	26.18	18.40	0.28
Reach-1	15.*	60.00	98.15	100.32	99.28	100.39	0.001570	2.11	28.47	19.06	0.30
Reach-1	15.*	70.00	98.15	100.43	99.38	100.52	0.001794	2.28	30.70	20.18	0.33
Reach-1	15.*	80.00	98.15	100.54	99.47	100.63	0.002046	2.43	32.91	21.73	0.35
Reach-1	15.*	90.00	98.15	100.64	99.56	100.74	0.002259	2.56	35.19	23.22	0.37
Reach-1	15.*	100.00	98.15	100.74	99.64	100.85	0.002427	2.67	37.47	24.51	0.38
Reach-1	15.*	200.00	98.15	101.50	100.33	101.67	0.002990	3.36	59.55	32.28	0.44
Reach-1	15.*	500.00	98.15	102.57	101.64	102.81	0.002774	4.38	199.12	238.41	0.45
Reach-1	15.*	750.00	98.15	102.99	102.55	103.25	0.002866	4.87	317.99	323.97	0.47
Reach-1	15.*	1000.00	98.15	103.33	102.89	103.59	0.002787	5.13	440.56	393.17	0.47
Reach-1	15.*	1500.00	98.15	103.76	103.42	104.02	0.002842	5.58	613.95	400.84	0.49
Reach-1	14.8	10.00	97.89	99.50	98.30	99.50	0.000157	0.57	17.55	14.73	0.09
Reach-1	14.8	20.00	97.89	99.73	98.50	99.74	0.000375	0.95	21.08	15.76	0.14
Reach-1	14.8	30.00	97.89	99.90	98.66	99.93	0.000598	1.26	23.87	16.58	0.18
Reach-1	14.8	40.00	97.89	100.05	98.80	100.09	0.000810	1.52	26.37	17.30	0.22
Reach-1	14.8	50.00	97.89	100.18	98.92	100.23	0.001008	1.74	28.67	17.93	0.24
Reach-1	14.8	60.00	97.89	100.30	99.03	100.36	0.001190	1.95	30.83	18.51	0.27
Reach-1	14.8	70.00	97.89	100.41	99.14	100.48	0.001357	2.13	32.91	19.04	0.29
Reach-1	14.8	80.00	97.89	100.51	99.24	100.59	0.001534	2.29	34.86	19.72	0.30
Reach-1	14.8	90.00	97.89	100.61	99.33	100.70	0.001756	2.44	36.82	21.03	0.33
Reach-1	14.8	100.00	97.89	100.70	99.42	100.80	0.001961	2.58	38.78	22.26	0.34
Reach-1	14.8	200.00	97.89	101.43	100.15	101.61	0.003188	3.41	58.60	32.14	0.45
Reach-1	14.8	500.00	97.89	102.51	101.68	102.76	0.002842	4.35	200.03	239.71	0.45
Reach-1	14.8	750.00	97.89	102.93	102.49	103.19	0.002911	4.83	319.24	325.07	0.47
Reach-1	14.8	1000.00	97.89	103.28	102.82	103.53	0.002800	5.06	443.51	394.88	0.47
Reach-1	14.8	1500.00	97.89	103.71	103.26	103.96	0.002842	5.50	616.94	401.00	0.48
Reach-1	14.6*	10.00	98.12	99.49	98.54	99.50	0.000251	0.65	15.37	15.49	0.12
Reach-1	14.6*	20.00	98.12	99.72	98.73	99.74	0.000552	1.05	18.99	16.73	0.17
Reach-1	14.6*	30.00	98.12	99.88	98.88	99.91	0.000843	1.37	21.85	17.69	0.22
Reach-1	14.6*	40.00	98.12	100.03	99.02	100.07	0.001103	1.64	24.41	18.50	0.25
Reach-1	14.6*	50.00	98.12	100.15	99.13	100.20	0.001337	1.87	26.77	19.22	0.28
Reach-1	14.6*	60.00	98.12	100.26	99.24	100.33	0.001623	2.07	29.03	20.74	0.31
Reach-1	14.6*	70.00	98.12	100.37	99.33	100.45	0.001887	2.23	31.33	22.33	0.33
Reach-1	14.6*	80.00	98.12	100.47	99.43	100.56	0.002119	2.38	33.59	23.75	0.35
Reach-1	14.6*	90.00	98.12	100.56	99.51	100.66	0.002302	2.51	35.87	24.95	0.37
Reach-1	14.6*	100.00	98.12	100.65	99.60	100.76	0.002460	2.62	38.12	26.09	0.38
Reach-1	14.6*	200.00	98.12	101.37	100.30	101.54	0.002926	3.35	59.67	32.07	0.43
Reach-1	14.6*	500.00	98.12	102.45	101.49	102.70	0.002735	4.38	199.21	238.27	0.45
Reach-1	14.6*	750.00	98.12	102.86	102.43	103.13	0.002896	4.92	314.39	321.59	0.47
Reach-1	14.6*	1000.00	98.12	103.21	102.77	103.47	0.002797	5.17	438.00	391.77	0.47
Reach-1	14.6*	1500.00	98.12	103.64	103.30	103.90	0.002845	5.61	612.50	400.75	0.49
Reach-1	14.4*	10.00	98.35	99.48	98.80	99.49	0.000495	0.79	12.72	16.42	0.16
Reach-1	14.4*	20.00	98.35	99.70	98.98	99.72	0.000963	1.22	16.41	18.02	0.22
Reach-1	14.4*	30.00	98.35	99.85	99.12	99.89	0.001375	1.55	19.32	19.22	0.27
Reach-1	14.4*	40.00	98.35	99.99	99.24	100.04	0.001837	1.82	22.04	21.54	0.32
Reach-1	14.4*	50.00	98.35	100.11	99.35	100.17	0.002187	2.02	24.73	23.43	0.35
Reach-1	14.4*	60.00	98.35	100.22	99.44	100.29	0.002422	2.19	27.37	24.77	0.37
Reach-1	14.4*	70.00	98.35	100.32	99.54	100.40	0.002598	2.33	30.00	26.05	0.38
Reach-1	14.4*	80.00	98.35	100.41	99.62	100.51	0.002747	2.46	32.54	27.22	0.40
Reach-1	14.4*	90.00	98.35	100.51	99.70	100.61	0.002855	2.57	35.08	28.34	0.41
Reach-1	14.4*	100.00	98.35	100.59	99.77	100.70	0.002932	2.66	37.60	29.35	0.41
Reach-1	14.4*	200.00	98.35	101.31	100.40	101.49	0.002825	3.36	59.58	31.40	0.43
Reach-1	14.4*	500.00	98.35	102.38	101.43	102.64	0.002704	4.42	199.28	238.17	0.45

Reach-1	14.4*	750.00	98.35	102.80	102.37	103.07	0.002880	4.97	314.04	320.95	0.48
Reach-1	14.4*	1000.00	98.35	103.14	102.71	103.41	0.002800	5.23	436.53	390.40	0.48
Reach-1	14.4*	1500.00	98.35	103.57	103.25	103.84	0.002861	5.69	610.29	400.50	0.49
Reach-1	14.2*	10.00	98.59	99.46	99.05	99.48	0.001372	1.03	9.67	18.03	0.25
Reach-1	14.2*	20.00	98.59	99.66	99.22	99.69	0.002262	1.48	13.55	21.49	0.33
Reach-1	14.2*	30.00	98.59	99.80	99.35	99.85	0.002787	1.78	16.84	23.52	0.37
Reach-1	14.2*	40.00	98.59	99.93	99.45	99.99	0.003106	2.01	19.86	24.97	0.40
Reach-1	14.2*	50.00	98.59	100.04	99.55	100.12	0.003299	2.20	22.77	26.30	0.42
Reach-1	14.2*	60.00	98.59	100.15	99.64	100.23	0.003408	2.34	25.64	27.54	0.43
Reach-1	14.2*	70.00	98.59	100.25	99.72	100.34	0.003441	2.45	28.53	28.72	0.43
Reach-1	14.2*	80.00	98.59	100.35	99.79	100.45	0.003356	2.56	31.29	28.99	0.43
Reach-1	14.2*	90.00	98.59	100.44	99.86	100.55	0.003268	2.65	33.96	29.16	0.43
Reach-1	14.2*	100.00	98.59	100.52	99.92	100.64	0.003203	2.74	36.52	29.32	0.43
Reach-1	14.2*	200.00	98.59	101.24	100.40	101.43	0.002973	3.45	58.05	30.65	0.44
Reach-1	14.2*	500.00	98.59	102.31	101.44	102.58	0.002874	4.55	193.89	235.07	0.47
Reach-1	14.2*	750.00	98.59	102.73	102.34	103.02	0.002973	5.06	311.57	320.81	0.49
Reach-1	14.2*	1000.00	98.59	103.07	102.67	103.35	0.002923	5.34	430.46	388.68	0.49
Reach-1	14.2*	1500.00	98.59	103.51	103.19	103.78	0.002940	5.78	606.26	400.25	0.50
Reach-1	14	10.00	98.82	99.37	99.27	99.42	0.009466	1.78	5.63	19.93	0.59
Reach-1	14	20.00	98.82	99.54	99.40	99.61	0.008914	2.15	9.31	23.67	0.60
Reach-1	14	30.00	98.82	99.68	99.50	99.76	0.007690	2.35	12.77	25.35	0.58
Reach-1	14	40.00	98.82	99.80	99.59	99.90	0.006869	2.50	16.03	26.70	0.57
Reach-1	14	50.00	98.82	99.92	99.66	100.03	0.006060	2.59	19.30	27.60	0.55
Reach-1	14	60.00	98.82	100.03	99.73	100.15	0.005362	2.67	22.44	27.81	0.52
Reach-1	14	70.00	98.82	100.14	99.79	100.26	0.004861	2.75	25.46	28.01	0.51
Reach-1	14	80.00	98.82	100.24	99.85	100.37	0.004534	2.83	28.27	28.19	0.50
Reach-1	14	90.00	98.82	100.34	99.91	100.47	0.004277	2.90	30.99	28.36	0.49
Reach-1	14	100.00	98.82	100.43	99.96	100.57	0.004097	2.98	33.56	28.53	0.48
Reach-1	14	200.00	98.82	101.15	100.40	101.36	0.003512	3.66	54.71	29.84	0.48
Reach-1	14	500.00	98.82	102.21	101.64	102.51	0.003358	4.82	181.24	226.21	0.50
Reach-1	14	750.00	98.82	102.65	102.32	102.96	0.003266	5.23	302.66	316.88	0.51
Reach-1	14	1000.00	98.82	102.98	102.65	103.28	0.003206	5.52	417.99	383.65	0.51
Reach-1	14	1500.00	98.82	103.44	103.15	103.72	0.003101	5.87	599.40	400.00	0.51
Reach-1	13.8*	10.00	98.56	99.09	99.03	99.18	0.015249	2.31	4.33	14.78	0.75
Reach-1	13.8*	20.00	98.56	99.31	99.19	99.41	0.010651	2.50	7.99	18.42	0.67
Reach-1	13.8*	30.00	98.56	99.50	99.31	99.60	0.008524	2.55	11.78	22.38	0.62
Reach-1	13.8*	40.00	98.56	99.66	99.42	99.76	0.006733	2.58	15.52	24.21	0.57
Reach-1	13.8*	50.00	98.56	99.80	99.50	99.91	0.005787	2.62	19.07	25.83	0.54
Reach-1	13.8*	60.00	98.56	99.93	99.58	100.04	0.005164	2.66	22.52	27.30	0.52
Reach-1	13.8*	70.00	98.56	100.05	99.65	100.16	0.004688	2.71	25.87	28.45	0.50
Reach-1	13.8*	80.00	98.56	100.16	99.71	100.28	0.004241	2.76	29.01	28.65	0.48
Reach-1	13.8*	90.00	98.56	100.26	99.78	100.39	0.003931	2.82	31.97	28.84	0.47
Reach-1	13.8*	100.00	98.56	100.36	99.83	100.49	0.003732	2.88	34.71	29.01	0.46
Reach-1	13.8*	200.00	98.56	101.10	100.29	101.29	0.003180	3.53	56.67	30.35	0.46
Reach-1	13.8*	500.00	98.56	102.15	101.39	102.44	0.003153	4.72	183.82	226.78	0.49
Reach-1	13.8*	750.00	98.56	102.59	102.23	102.89	0.003144	5.17	303.48	316.09	0.50
Reach-1	13.8*	1000.00	98.56	102.92	102.56	103.21	0.003110	5.48	418.50	382.78	0.50
Reach-1	13.8*	1500.00	98.56	103.37	103.08	103.65	0.003066	5.87	597.77	400.16	0.51
Reach-1	13.6*	10.00	98.30	98.93	98.77	98.98	0.006548	1.83	5.46	13.93	0.52
Reach-1	13.6*	20.00	98.30	99.19	98.93	99.26	0.005391	2.13	9.41	16.54	0.50
Reach-1	13.6*	30.00	98.30	99.38	99.07	99.46	0.005028	2.34	12.83	18.51	0.50
Reach-1	13.6*	40.00	98.30	99.55	99.18	99.64	0.005029	2.48	16.14	21.32	0.50
Reach-1	13.6*	50.00	98.30	99.70	99.28	99.80	0.004751	2.56	19.56	23.60	0.49
Reach-1	13.6*	60.00	98.30	99.84	99.37	99.94	0.004405	2.62	22.94	25.22	0.48
Reach-1	13.6*	70.00	98.30	99.96	99.46	100.07	0.004151	2.67	26.22	26.70	0.47
Reach-1	13.6*	80.00	98.30	100.08	99.55	100.19	0.003961	2.72	29.40	28.06	0.47

Reach-1	13.6*	90.00	98.30	100.19	99.62	100.31	0.003793	2.77	32.51	29.24	0.46
Reach-1	13.6*	100.00	98.30	100.29	99.69	100.41	0.003553	2.82	35.45	29.43	0.45
Reach-1	13.6*	200.00	98.30	101.04	100.21	101.23	0.002975	3.44	58.19	30.86	0.44
Reach-1	13.6*	500.00	98.30	102.09	101.19	102.37	0.002997	4.62	187.02	228.66	0.48
Reach-1	13.6*	750.00	98.30	102.53	102.14	102.82	0.003037	5.10	306.03	317.17	0.49
Reach-1	13.6*	1000.00	98.30	102.86	102.48	103.15	0.003014	5.41	421.79	384.17	0.50
Reach-1	13.6*	1500.00	98.30	103.31	103.01	103.59	0.003010	5.83	599.41	400.34	0.51
Reach-1	13.4*	10.00	98.04	98.89	98.49	98.91	0.001668	1.20	8.34	14.28	0.28
Reach-1	13.4*	20.00	98.04	99.14	98.67	99.18	0.002251	1.65	12.15	16.15	0.33
Reach-1	13.4*	30.00	98.04	99.33	98.81	99.39	0.002622	1.96	15.34	17.57	0.37
Reach-1	13.4*	40.00	98.04	99.49	98.93	99.56	0.002852	2.19	18.27	18.77	0.39
Reach-1	13.4*	50.00	98.04	99.63	99.04	99.72	0.003161	2.37	21.10	20.76	0.41
Reach-1	13.4*	60.00	98.04	99.77	99.14	99.86	0.003383	2.49	24.05	23.07	0.43
Reach-1	13.4*	70.00	98.04	99.89	99.23	100.00	0.003394	2.59	27.06	24.62	0.43
Reach-1	13.4*	80.00	98.04	100.01	99.31	100.12	0.003391	2.67	30.01	26.05	0.44
Reach-1	13.4*	90.00	98.04	100.12	99.39	100.23	0.003372	2.73	32.92	27.39	0.44
Reach-1	13.4*	100.00	98.04	100.22	99.46	100.34	0.003345	2.79	35.78	28.62	0.44
Reach-1	13.4*	200.00	98.04	100.99	100.09	101.17	0.002885	3.38	59.17	31.35	0.43
Reach-1	13.4*	500.00	98.04	102.04	101.11	102.31	0.002901	4.54	189.99	230.84	0.47
Reach-1	13.4*	750.00	98.04	102.47	102.06	102.76	0.002967	5.03	308.80	318.76	0.48
Reach-1	13.4*	1000.00	98.04	102.80	102.41	103.09	0.002942	5.34	425.62	386.15	0.49
Reach-1	13.4*	1500.00	98.04	103.25	102.94	103.53	0.002960	5.77	602.21	400.50	0.50
Reach-1	13.2*	10.00	97.79	98.88	98.22	98.89	0.000603	0.87	11.47	14.57	0.17
Reach-1	13.2*	20.00	97.79	99.12	98.40	99.15	0.001083	1.32	15.18	16.02	0.24
Reach-1	13.2*	30.00	97.79	99.30	98.55	99.34	0.001463	1.65	18.20	17.14	0.28
Reach-1	13.2*	40.00	97.79	99.46	98.68	99.51	0.001757	1.91	20.95	18.10	0.31
Reach-1	13.2*	50.00	97.79	99.60	98.79	99.67	0.001993	2.13	23.51	18.95	0.34
Reach-1	13.2*	60.00	97.79	99.72	98.90	99.81	0.002267	2.31	26.00	20.42	0.36
Reach-1	13.2*	70.00	97.79	99.84	98.99	99.94	0.002530	2.45	28.58	22.29	0.38
Reach-1	13.2*	80.00	97.79	99.96	99.08	100.06	0.002715	2.57	31.17	23.92	0.40
Reach-1	13.2*	90.00	97.79	100.06	99.17	100.17	0.002830	2.66	33.78	25.29	0.41
Reach-1	13.2*	100.00	97.79	100.16	99.25	100.28	0.002917	2.75	36.38	26.58	0.41
Reach-1	13.2*	200.00	97.79	100.93	99.94	101.11	0.002887	3.35	59.66	31.85	0.43
Reach-1	13.2*	500.00	97.79	101.99	101.05	102.25	0.002816	4.45	194.70	234.22	0.46
Reach-1	13.2*	750.00	97.79	102.42	101.99	102.69	0.002887	4.94	314.17	321.14	0.48
Reach-1	13.2*	1000.00	97.79	102.75	102.33	103.03	0.002860	5.24	432.12	388.33	0.48
Reach-1	13.2*	1500.00	97.79	103.19	102.87	103.46	0.002899	5.68	607.46	400.66	0.49
Reach-1	13.*	10.00	97.53	98.87	97.95	98.88	0.000285	0.69	14.52	14.68	0.12
Reach-1	13.*	20.00	97.53	99.11	98.14	99.13	0.000606	1.10	18.14	15.88	0.18
Reach-1	13.*	30.00	97.53	99.29	98.29	99.32	0.000903	1.43	21.03	16.81	0.22
Reach-1	13.*	40.00	97.53	99.44	98.43	99.48	0.001162	1.69	23.64	17.63	0.26
Reach-1	13.*	50.00	97.53	99.57	98.55	99.63	0.001389	1.92	26.06	18.36	0.28
Reach-1	13.*	60.00	97.53	99.69	98.66	99.76	0.001587	2.12	28.36	19.02	0.31
Reach-1	13.*	70.00	97.53	99.81	98.76	99.89	0.001805	2.29	30.59	20.10	0.33
Reach-1	13.*	80.00	97.53	99.92	98.85	100.01	0.002059	2.44	32.80	21.66	0.35
Reach-1	13.*	90.00	97.53	100.02	98.94	100.12	0.002274	2.57	35.07	23.15	0.37
Reach-1	13.*	100.00	97.53	100.11	99.02	100.22	0.002443	2.68	37.36	24.45	0.38
Reach-1	13.*	200.00	97.53	100.87	99.71	101.05	0.003003	3.36	59.47	32.27	0.44
Reach-1	13.*	500.00	97.53	101.94	101.02	102.19	0.002825	4.41	196.77	236.41	0.46
Reach-1	13.*	750.00	97.53	102.37	101.93	102.63	0.002883	4.88	316.92	323.31	0.47
Reach-1	13.*	1000.00	97.53	102.70	102.27	102.96	0.002837	5.16	436.44	391.04	0.48
Reach-1	13.*	1500.00	97.53	103.14	102.80	103.40	0.002871	5.60	611.58	400.84	0.49
Reach-1	12.8	10.00	97.27	98.87	97.68	98.87	0.000160	0.57	17.40	14.68	0.09
Reach-1	12.8	20.00	97.27	99.10	97.88	99.12	0.000381	0.95	20.95	15.73	0.15
Reach-1	12.8	30.00	97.27	99.28	98.04	99.30	0.000607	1.26	23.75	16.54	0.19
Reach-1	12.8	40.00	97.27	99.42	98.18	99.46	0.000821	1.52	26.25	17.26	0.22

Reach-1	12.8	50.00	97.27	99.55	98.30	99.60	0.001020	1.75	28.54	17.90	0.24
Reach-1	12.8	60.00	97.27	99.67	98.41	99.73	0.001202	1.95	30.72	18.48	0.27
Reach-1	12.8	70.00	97.27	99.79	98.52	99.86	0.001369	2.13	32.81	19.02	0.29
Reach-1	12.8	80.00	97.27	99.89	98.62	99.97	0.001541	2.30	34.77	19.66	0.30
Reach-1	12.8	90.00	97.27	99.98	98.71	100.08	0.001765	2.45	36.72	20.96	0.33
Reach-1	12.8	100.00	97.27	100.07	98.80	100.18	0.001972	2.59	38.68	22.20	0.35
Reach-1	12.8	200.00	97.27	100.80	99.53	100.99	0.003199	3.42	58.51	32.11	0.45
Reach-1	12.8	500.00	97.27	101.88	101.06	102.13	0.002905	4.39	197.24	237.34	0.46
Reach-1	12.8	750.00	97.27	102.31	101.87	102.57	0.002932	4.84	317.97	324.29	0.47
Reach-1	12.8	1000.00	97.27	102.65	102.20	102.90	0.002857	5.10	438.90	392.52	0.47
Reach-1	12.8	1500.00	97.27	103.09	102.64	103.34	0.002875	5.52	614.21	401.00	0.48
Reach-1	12.6*	10.00	97.50	98.86	97.92	98.87	0.000258	0.66	15.22	15.44	0.12
Reach-1	12.6*	20.00	97.50	99.09	98.11	99.11	0.000564	1.06	18.85	16.69	0.18
Reach-1	12.6*	30.00	97.50	99.26	98.26	99.29	0.000857	1.38	21.72	17.65	0.22
Reach-1	12.6*	40.00	97.50	99.40	98.40	99.44	0.001120	1.65	24.28	18.47	0.25
Reach-1	12.6*	50.00	97.50	99.52	98.51	99.58	0.001355	1.88	26.63	19.19	0.28
Reach-1	12.6*	60.00	97.50	99.64	98.62	99.70	0.001641	2.08	28.91	20.69	0.31
Reach-1	12.6*	70.00	97.50	99.75	98.71	99.82	0.001911	2.24	31.22	22.35	0.33
Reach-1	12.6*	80.00	97.50	99.84	98.81	99.93	0.002145	2.39	33.50	23.81	0.35
Reach-1	12.6*	90.00	97.50	99.94	98.89	100.04	0.002327	2.52	35.78	25.01	0.37
Reach-1	12.6*	100.00	97.50	100.03	98.98	100.13	0.002482	2.63	38.05	26.15	0.38
Reach-1	12.6*	200.00	97.50	100.75	99.68	100.92	0.002922	3.35	59.69	32.06	0.43
Reach-1	12.6*	500.00	97.50	101.82	100.87	102.07	0.002751	4.39	198.33	237.77	0.45
Reach-1	12.6*	750.00	97.50	102.23	101.80	102.51	0.002910	4.93	313.55	321.45	0.48
Reach-1	12.6*	1000.00	97.50	102.58	102.15	102.85	0.002802	5.17	437.76	392.14	0.47
Reach-1	12.6*	1500.00	97.50	103.02	102.68	103.28	0.002861	5.62	611.14	400.75	0.49
Reach-1	12.4*	10.00	97.73	98.85	98.17	98.86	0.000501	0.79	12.67	16.42	0.16
Reach-1	12.4*	20.00	97.73	99.07	98.35	99.09	0.000969	1.22	16.39	18.03	0.23
Reach-1	12.4*	30.00	97.73	99.23	98.49	99.26	0.001380	1.55	19.32	19.25	0.27
Reach-1	12.4*	40.00	97.73	99.36	98.62	99.41	0.001829	1.81	22.04	21.48	0.32
Reach-1	12.4*	50.00	97.73	99.48	98.72	99.54	0.002176	2.02	24.74	23.35	0.35
Reach-1	12.4*	60.00	97.73	99.59	98.82	99.66	0.002408	2.19	27.39	24.71	0.37
Reach-1	12.4*	70.00	97.73	99.69	98.91	99.78	0.002583	2.33	30.03	25.99	0.38
Reach-1	12.4*	80.00	97.73	99.79	98.99	99.88	0.002729	2.46	32.58	27.17	0.40
Reach-1	12.4*	90.00	97.73	99.88	99.07	99.98	0.002840	2.56	35.12	28.29	0.41
Reach-1	12.4*	100.00	97.73	99.97	99.15	100.08	0.002924	2.66	37.65	29.37	0.41
Reach-1	12.4*	200.00	97.73	100.69	99.77	100.86	0.002804	3.35	59.71	31.40	0.43
Reach-1	12.4*	500.00	97.73	101.76	100.79	102.01	0.002709	4.42	198.94	238.36	0.45
Reach-1	12.4*	750.00	97.73	102.17	101.75	102.45	0.002872	4.97	314.64	322.08	0.48
Reach-1	12.4*	1000.00	97.73	102.52	102.09	102.79	0.002789	5.22	437.72	391.99	0.48
Reach-1	12.4*	1500.00	97.73	102.95	102.63	103.22	0.002855	5.69	610.80	400.50	0.49
Reach-1	12.2*	10.00	97.96	98.83	98.43	98.85	0.001414	1.05	9.57	17.94	0.25
Reach-1	12.2*	20.00	97.96	99.03	98.59	99.06	0.002314	1.49	13.45	21.45	0.33
Reach-1	12.2*	30.00	97.96	99.17	98.72	99.22	0.002833	1.79	16.76	23.53	0.37
Reach-1	12.2*	40.00	97.96	99.30	98.83	99.36	0.003140	2.02	19.80	25.00	0.40
Reach-1	12.2*	50.00	97.96	99.41	98.93	99.49	0.003322	2.20	22.74	26.33	0.42
Reach-1	12.2*	60.00	97.96	99.52	99.02	99.61	0.003409	2.34	25.65	27.56	0.43
Reach-1	12.2*	70.00	97.96	99.63	99.10	99.72	0.003425	2.45	28.55	28.68	0.43
Reach-1	12.2*	80.00	97.96	99.72	99.17	99.82	0.003339	2.55	31.33	28.99	0.43
Reach-1	12.2*	90.00	97.96	99.81	99.23	99.92	0.003253	2.65	34.01	29.16	0.43
Reach-1	12.2*	100.00	97.96	99.90	99.29	100.02	0.003186	2.73	36.57	29.32	0.43
Reach-1	12.2*	200.00	97.96	100.62	99.77	100.81	0.002948	3.44	58.20	30.64	0.44
Reach-1	12.2*	500.00	97.96	101.68	100.81	101.95	0.002884	4.56	193.16	234.59	0.47
Reach-1	12.2*	750.00	97.96	102.11	101.72	102.39	0.002996	5.08	310.01	320.13	0.49
Reach-1	12.2*	1000.00	97.96	102.44	102.05	102.72	0.002929	5.35	429.90	388.81	0.49
Reach-1	12.2*	1500.00	97.96	102.88	102.57	103.16	0.002959	5.79	604.54	400.25	0.50

Reach-1	12	10.00	98.19	98.73	98.64	98.78	0.009884	1.80	5.55	19.84	0.60
Reach-1	12	20.00	98.19	98.90	98.77	98.98	0.008971	2.15	9.29	23.65	0.61
Reach-1	12	30.00	98.19	99.05	98.87	99.13	0.007587	2.34	12.82	25.38	0.58
Reach-1	12	40.00	98.19	99.18	98.96	99.27	0.006728	2.48	16.14	26.74	0.56
Reach-1	12	50.00	98.19	99.30	99.03	99.40	0.005908	2.57	19.46	27.61	0.54
Reach-1	12	60.00	98.19	99.41	99.10	99.52	0.005204	2.65	22.65	27.82	0.52
Reach-1	12	70.00	98.19	99.52	99.16	99.64	0.004719	2.72	25.69	28.02	0.50
Reach-1	12	80.00	98.19	99.62	99.22	99.74	0.004405	2.80	28.53	28.21	0.49
Reach-1	12	90.00	98.19	99.72	99.28	99.85	0.004171	2.88	31.24	28.38	0.48
Reach-1	12	100.00	98.19	99.81	99.33	99.94	0.003999	2.96	33.82	28.54	0.48
Reach-1	12	200.00	98.19	100.54	99.77	100.74	0.003442	3.63	55.06	29.87	0.47
Reach-1	12	500.00	98.19	101.59	101.01	101.89	0.003266	4.77	184.58	229.19	0.49
Reach-1	12	750.00	98.19	102.04	101.69	102.33	0.003204	5.19	305.98	319.00	0.50
Reach-1	12	1000.00	98.19	102.37	102.02	102.66	0.003109	5.46	424.75	387.21	0.50
Reach-1	12	1500.00	98.19	102.82	102.52	103.10	0.003041	5.83	603.97	400.00	0.51
Reach-1	11.8*	10.00	97.93	98.47	98.40	98.55	0.014540	2.27	4.40	14.86	0.74
Reach-1	11.8*	20.00	97.93	98.69	98.56	98.79	0.010093	2.46	8.12	18.40	0.65
Reach-1	11.8*	30.00	97.93	98.88	98.69	98.97	0.008148	2.51	11.97	22.49	0.61
Reach-1	11.8*	40.00	97.93	99.04	98.79	99.14	0.006486	2.54	15.73	24.32	0.56
Reach-1	11.8*	50.00	97.93	99.18	98.88	99.28	0.005593	2.59	19.30	25.94	0.53
Reach-1	11.8*	60.00	97.93	99.31	98.95	99.42	0.004985	2.63	22.81	27.43	0.51
Reach-1	11.8*	70.00	97.93	99.43	99.02	99.54	0.004509	2.67	26.19	28.47	0.49
Reach-1	11.8*	80.00	97.93	99.54	99.08	99.66	0.004095	2.73	29.33	28.67	0.48
Reach-1	11.8*	90.00	97.93	99.64	99.15	99.76	0.003820	2.79	32.26	28.86	0.47
Reach-1	11.8*	100.00	97.93	99.74	99.21	99.87	0.003633	2.86	35.01	29.03	0.46
Reach-1	11.8*	200.00	97.93	100.48	99.66	100.67	0.003117	3.51	57.04	30.37	0.45
Reach-1	11.8*	500.00	97.93	101.54	100.76	101.82	0.003057	4.66	187.72	230.26	0.48
Reach-1	11.8*	750.00	97.93	101.97	101.60	102.26	0.003071	5.13	307.69	318.80	0.49
Reach-1	11.8*	1000.00	97.93	102.31	101.93	102.59	0.003007	5.40	426.09	386.79	0.50
Reach-1	11.8*	1500.00	97.93	102.75	102.45	103.03	0.002990	5.81	603.68	400.16	0.50
Reach-1	11.6*	10.00	97.68	98.31	98.14	98.36	0.006039	1.78	5.62	14.07	0.50
Reach-1	11.6*	20.00	97.68	98.57	98.31	98.64	0.005061	2.08	9.62	16.70	0.48
Reach-1	11.6*	30.00	97.68	98.77	98.44	98.85	0.004785	2.30	13.06	18.64	0.48
Reach-1	11.6*	40.00	97.68	98.93	98.55	99.02	0.004836	2.44	16.38	21.46	0.49
Reach-1	11.6*	50.00	97.68	99.08	98.65	99.18	0.004578	2.53	19.80	23.65	0.49
Reach-1	11.6*	60.00	97.68	99.22	98.74	99.33	0.004254	2.59	23.20	25.28	0.48
Reach-1	11.6*	70.00	97.68	99.35	98.83	99.46	0.004019	2.64	26.50	26.76	0.47
Reach-1	11.6*	80.00	97.68	99.46	98.92	99.58	0.003851	2.70	29.67	28.12	0.46
Reach-1	11.6*	90.00	97.68	99.57	98.99	99.69	0.003709	2.75	32.73	29.25	0.46
Reach-1	11.6*	100.00	97.68	99.67	99.06	99.79	0.003482	2.80	35.67	29.44	0.45
Reach-1	11.6*	200.00	97.68	100.43	99.58	100.61	0.002932	3.42	58.47	30.88	0.44
Reach-1	11.6*	500.00	97.68	101.48	100.57	101.75	0.002908	4.57	191.00	231.99	0.47
Reach-1	11.6*	750.00	97.68	101.91	101.51	102.20	0.002971	5.06	310.06	319.40	0.49
Reach-1	11.6*	1000.00	97.68	102.25	101.85	102.53	0.002919	5.34	428.92	387.48	0.49
Reach-1	11.6*	1500.00	97.68	102.69	102.38	102.97	0.002943	5.78	604.75	400.34	0.50
Reach-1	11.4*	10.00	97.42	98.28	97.86	98.30	0.001557	1.17	8.55	14.41	0.27
Reach-1	11.4*	20.00	97.42	98.53	98.04	98.57	0.002122	1.61	12.42	16.29	0.33
Reach-1	11.4*	30.00	97.42	98.72	98.18	98.77	0.002499	1.92	15.61	17.71	0.36
Reach-1	11.4*	40.00	97.42	98.87	98.31	98.95	0.002745	2.16	18.53	18.89	0.38
Reach-1	11.4*	50.00	97.42	99.02	98.41	99.10	0.003062	2.34	21.38	20.96	0.41
Reach-1	11.4*	60.00	97.42	99.15	98.51	99.25	0.003249	2.46	24.39	23.17	0.42
Reach-1	11.4*	70.00	97.42	99.28	98.60	99.38	0.003268	2.55	27.42	24.72	0.43
Reach-1	11.4*	80.00	97.42	99.40	98.68	99.50	0.003280	2.64	30.35	26.14	0.43
Reach-1	11.4*	90.00	97.42	99.50	98.76	99.62	0.003285	2.71	33.21	27.45	0.43
Reach-1	11.4*	100.00	97.42	99.61	98.83	99.72	0.003270	2.77	36.07	28.70	0.44
Reach-1	11.4*	200.00	97.42	100.37	99.47	100.55	0.002834	3.36	59.51	31.38	0.43
Reach-1	11.4*	500.00	97.42	101.43	100.48	101.69	0.002800	4.48	194.68	234.71	0.46

Reach-1	11.4*	750.00	97.42	101.86	101.44	102.14	0.002888	4.98	313.63	321.45	0.48
Reach-1	11.4*	1000.00	97.42	102.20	101.78	102.47	0.002840	5.26	433.58	389.84	0.48
Reach-1	11.4*	1500.00	97.42	102.63	102.32	102.91	0.002882	5.71	608.55	400.50	0.49
Reach-1	11.2*	10.00	97.16	98.26	97.59	98.28	0.000578	0.86	11.63	14.62	0.17
Reach-1	11.2*	20.00	97.16	98.51	97.78	98.53	0.001042	1.30	15.38	16.08	0.23
Reach-1	11.2*	30.00	97.16	98.69	97.92	98.73	0.001420	1.63	18.40	17.21	0.28
Reach-1	11.2*	40.00	97.16	98.84	98.06	98.90	0.001719	1.89	21.12	18.17	0.31
Reach-1	11.2*	50.00	97.16	98.98	98.17	99.05	0.001956	2.11	23.69	19.04	0.33
Reach-1	11.2*	60.00	97.16	99.11	98.27	99.19	0.002238	2.29	26.24	20.69	0.36
Reach-1	11.2*	70.00	97.16	99.23	98.37	99.32	0.002489	2.43	28.86	22.57	0.38
Reach-1	11.2*	80.00	97.16	99.34	98.46	99.44	0.002662	2.54	31.46	24.12	0.39
Reach-1	11.2*	90.00	97.16	99.45	98.54	99.56	0.002782	2.64	34.03	25.44	0.40
Reach-1	11.2*	100.00	97.16	99.55	98.62	99.66	0.002867	2.73	36.63	26.69	0.41
Reach-1	11.2*	200.00	97.16	100.32	99.32	100.49	0.002840	3.33	59.97	31.87	0.43
Reach-1	11.2*	500.00	97.16	101.38	100.42	101.63	0.002750	4.41	197.55	236.87	0.45
Reach-1	11.2*	750.00	97.16	101.81	101.36	102.08	0.002851	4.92	316.30	322.83	0.47
Reach-1	11.2*	1000.00	97.16	102.14	101.71	102.41	0.002798	5.19	437.14	391.38	0.48
Reach-1	11.2*	1500.00	97.16	102.58	102.24	102.85	0.002850	5.64	611.40	400.66	0.49
Reach-1	11.*	10.00	96.91	98.26	97.33	98.27	0.000278	0.68	14.64	14.72	0.12
Reach-1	11.*	20.00	96.91	98.50	97.52	98.52	0.000591	1.09	18.30	15.93	0.18
Reach-1	11.*	30.00	96.91	98.67	97.67	98.71	0.000885	1.42	21.19	16.86	0.22
Reach-1	11.*	40.00	96.91	98.82	97.81	98.87	0.001146	1.68	23.77	17.67	0.26
Reach-1	11.*	50.00	96.91	98.96	97.93	99.01	0.001372	1.91	26.18	18.39	0.28
Reach-1	11.*	60.00	96.91	99.08	98.04	99.15	0.001564	2.10	28.51	19.07	0.30
Reach-1	11.*	70.00	96.91	99.20	98.14	99.28	0.001787	2.28	30.76	20.23	0.33
Reach-1	11.*	80.00	96.91	99.30	98.23	99.39	0.002037	2.43	32.98	21.78	0.35
Reach-1	11.*	90.00	96.91	99.40	98.32	99.50	0.002257	2.56	35.20	23.23	0.37
Reach-1	11.*	100.00	96.91	99.50	98.40	99.61	0.002427	2.67	37.48	24.54	0.38
Reach-1	11.*	200.00	96.91	100.26	99.09	100.43	0.002967	3.35	59.70	32.30	0.43
Reach-1	11.*	500.00	96.91	101.33	100.40	101.58	0.002761	4.37	199.61	238.79	0.45
Reach-1	11.*	750.00	96.91	101.75	101.31	102.01	0.002856	4.86	318.52	324.28	0.47
Reach-1	11.*	1000.00	96.91	102.09	101.65	102.35	0.002784	5.12	440.70	393.22	0.47
Reach-1	11.*	1500.00	96.91	102.53	102.18	102.78	0.002834	5.57	614.60	400.84	0.48
Reach-1	10.8	10.00	96.65	98.26	97.06	98.26	0.000157	0.57	17.52	14.72	0.09
Reach-1	10.8	20.00	96.65	98.49	97.26	98.51	0.000373	0.95	21.11	15.77	0.14
Reach-1	10.8	30.00	96.65	98.66	97.42	98.69	0.000597	1.26	23.90	16.59	0.18
Reach-1	10.8	40.00	96.65	98.81	97.56	98.85	0.000810	1.52	26.37	17.29	0.22
Reach-1	10.8	50.00	96.65	98.94	97.68	98.99	0.001008	1.74	28.66	17.93	0.24
Reach-1	10.8	60.00	96.65	99.06	97.79	99.12	0.001186	1.94	30.87	18.52	0.27
Reach-1	10.8	70.00	96.65	99.17	97.90	99.24	0.001350	2.12	32.97	19.06	0.28
Reach-1	10.8	80.00	96.65	99.28	98.00	99.36	0.001529	2.29	34.93	19.77	0.30
Reach-1	10.8	90.00	96.65	99.37	98.09	99.46	0.001755	2.44	36.83	21.04	0.33
Reach-1	10.8	100.00	96.65	99.46	98.18	99.56	0.001960	2.58	38.80	22.27	0.34
Reach-1	10.8	200.00	96.65	100.19	98.91	100.37	0.003172	3.41	58.72	32.20	0.44
Reach-1	10.8	500.00	96.65	101.27	100.44	101.52	0.002830	4.35	200.55	240.15	0.45
Reach-1	10.8	750.00	96.65	101.70	101.25	101.95	0.002902	4.82	319.82	325.43	0.47
Reach-1	10.8	1000.00	96.65	102.04	101.58	102.29	0.002798	5.06	443.64	394.95	0.47
Reach-1	10.8	1500.00	96.65	102.47	102.02	102.72	0.002833	5.49	617.66	401.00	0.48
Reach-1	10.6*	10.00	96.88	98.25	97.30	98.26	0.000252	0.65	15.34	15.48	0.12
Reach-1	10.6*	20.00	96.88	98.48	97.49	98.50	0.000550	1.05	19.02	16.74	0.17
Reach-1	10.6*	30.00	96.88	98.65	97.64	98.67	0.000840	1.37	21.88	17.70	0.22
Reach-1	10.6*	40.00	96.88	98.79	97.78	98.83	0.001103	1.64	24.40	18.50	0.25
Reach-1	10.6*	50.00	96.88	98.91	97.89	98.96	0.001338	1.87	26.76	19.22	0.28
Reach-1	10.6*	60.00	96.88	99.03	98.00	99.09	0.001617	2.06	29.08	20.77	0.31
Reach-1	10.6*	70.00	96.88	99.13	98.09	99.21	0.001877	2.23	31.41	22.38	0.33
Reach-1	10.6*	80.00	96.88	99.23	98.19	99.32	0.002107	2.38	33.68	23.80	0.35

Reach-1	10.6*	90.00	96.88	99.32	98.27	99.42	0.002299	2.51	35.88	24.96	0.37
Reach-1	10.6*	100.00	96.88	99.41	98.36	99.52	0.002458	2.62	38.14	26.10	0.38
Reach-1	10.6*	200.00	96.88	100.13	99.06	100.31	0.002906	3.34	59.80	32.08	0.43
Reach-1	10.6*	500.00	96.88	101.21	100.26	101.46	0.002721	4.37	199.83	238.80	0.45
Reach-1	10.6*	750.00	96.88	101.62	101.19	101.89	0.002879	4.91	315.42	322.24	0.47
Reach-1	10.6*	1000.00	96.88	101.97	101.53	102.23	0.002795	5.16	438.17	391.86	0.47
Reach-1	10.6*	1500.00	96.88	102.40	102.06	102.67	0.002834	5.60	613.44	400.75	0.49
Reach-1	10.4*	10.00	97.12	98.24	97.56	98.25	0.000505	0.79	12.64	16.40	0.16
Reach-1	10.4*	20.00	97.12	98.46	97.74	98.48	0.000968	1.22	16.40	18.03	0.23
Reach-1	10.4*	30.00	97.12	98.62	97.88	98.65	0.001382	1.55	19.30	19.24	0.27
Reach-1	10.4*	40.00	97.12	98.75	98.01	98.80	0.001852	1.82	21.98	21.52	0.32
Reach-1	10.4*	50.00	97.12	98.87	98.11	98.93	0.002204	2.03	24.67	23.42	0.35
Reach-1	10.4*	60.00	97.12	98.98	98.21	99.05	0.002423	2.19	27.38	24.80	0.37
Reach-1	10.4*	70.00	97.12	99.08	98.30	99.17	0.002590	2.33	30.04	26.09	0.38
Reach-1	10.4*	80.00	97.12	99.18	98.38	99.27	0.002738	2.46	32.59	27.26	0.40
Reach-1	10.4*	90.00	97.12	99.27	98.46	99.37	0.002866	2.57	35.04	28.34	0.41
Reach-1	10.4*	100.00	97.12	99.35	98.54	99.46	0.002944	2.66	37.56	29.34	0.41
Reach-1	10.4*	200.00	97.12	100.08	99.16	100.25	0.002813	3.35	59.65	31.39	0.43
Reach-1	10.4*	500.00	97.12	101.14	100.18	101.40	0.002746	4.45	196.97	236.62	0.46
Reach-1	10.4*	750.00	97.12	101.55	101.14	101.83	0.002915	5.00	311.79	320.24	0.48
Reach-1	10.4*	1000.00	97.12	101.89	101.47	102.17	0.002858	5.28	431.94	388.95	0.48
Reach-1	10.4*	1500.00	97.12	102.33	102.02	102.60	0.002897	5.72	607.24	400.50	0.49
Reach-1	10.2*	10.00	97.35	98.22	97.81	98.23	0.001391	1.04	9.63	18.00	0.25
Reach-1	10.2*	20.00	97.35	98.42	97.98	98.45	0.002246	1.47	13.59	21.53	0.33
Reach-1	10.2*	30.00	97.35	98.56	98.11	98.61	0.002769	1.78	16.88	23.54	0.37
Reach-1	10.2*	40.00	97.35	98.69	98.21	98.75	0.003113	2.02	19.84	24.97	0.40
Reach-1	10.2*	50.00	97.35	98.80	98.31	98.88	0.003307	2.20	22.76	26.29	0.42
Reach-1	10.2*	60.00	97.35	98.91	98.40	99.00	0.003376	2.33	25.73	27.58	0.43
Reach-1	10.2*	70.00	97.35	99.01	98.48	99.11	0.003396	2.44	28.66	28.77	0.43
Reach-1	10.2*	80.00	97.35	99.11	98.55	99.21	0.003309	2.55	31.43	29.00	0.43
Reach-1	10.2*	90.00	97.35	99.20	98.62	99.31	0.003263	2.65	33.98	29.16	0.43
Reach-1	10.2*	100.00	97.35	99.29	98.68	99.40	0.003199	2.74	36.53	29.32	0.43
Reach-1	10.2*	200.00	97.35	100.01	99.16	100.19	0.002948	3.44	58.21	30.65	0.44
Reach-1	10.2*	500.00	97.35	101.07	100.20	101.34	0.002866	4.55	194.28	235.40	0.47
Reach-1	10.2*	750.00	97.35	101.50	101.10	101.78	0.002957	5.05	312.55	321.42	0.48
Reach-1	10.2*	1000.00	97.35	101.83	101.43	102.11	0.002933	5.35	429.70	388.28	0.49
Reach-1	10.2*	1500.00	97.35	102.27	101.95	102.54	0.002936	5.77	606.54	400.25	0.50
Reach-1	10	10.00	97.58	98.12	98.03	98.17	0.010138	1.82	5.50	19.79	0.61
Reach-1	10	20.00	97.58	98.30	98.16	98.37	0.008618	2.12	9.42	23.77	0.59
Reach-1	10	30.00	97.58	98.44	98.27	98.52	0.007505	2.33	12.87	25.40	0.58
Reach-1	10	40.00	97.58	98.56	98.35	98.66	0.006918	2.50	15.99	26.68	0.57
Reach-1	10	50.00	97.58	98.68	98.42	98.78	0.006101	2.60	19.26	27.60	0.55
Reach-1	10	60.00	97.58	98.80	98.49	98.91	0.005249	2.66	22.59	27.82	0.52
Reach-1	10	70.00	97.58	98.91	98.55	99.03	0.004739	2.73	25.66	28.02	0.50
Reach-1	10	80.00	97.58	99.01	98.61	99.13	0.004434	2.81	28.47	28.20	0.49
Reach-1	10	90.00	97.58	99.10	98.67	99.23	0.004267	2.90	31.02	28.37	0.49
Reach-1	10	100.00	97.58	99.19	98.72	99.33	0.004090	2.98	33.58	28.53	0.48
Reach-1	10	200.00	97.58	99.92	99.16	100.13	0.003476	3.64	54.89	29.85	0.47
Reach-1	10	500.00	97.58	100.97	100.40	101.27	0.003343	4.81	181.78	226.69	0.50
Reach-1	10	750.00	97.58	101.42	101.08	101.72	0.003235	5.21	304.32	317.94	0.50
Reach-1	10	1000.00	97.58	101.74	101.41	102.04	0.003229	5.54	416.45	382.83	0.51
Reach-1	10	1500.00	97.58	102.20	101.91	102.48	0.003098	5.87	599.66	400.00	0.51

Reach-1	18.8	30.00	100.41	102.55	101.22	102.57	0.000482	1.14	26.29	18.07	0.17
Reach-1	18.8	40.00	100.41	102.70	101.36	102.73	0.000688	1.38	28.94	19.52	0.20
Reach-1	18.8	50.00	100.41	102.82	101.49	102.86	0.000903	1.59	31.52	21.25	0.23
Reach-1	18.8	60.00	100.41	102.93	101.60	102.98	0.001107	1.76	34.00	22.78	0.25
Reach-1	18.8	70.00	100.41	103.04	101.70	103.10	0.001292	1.92	36.46	24.21	0.28
Reach-1	18.8	80.00	100.41	103.14	101.80	103.20	0.001457	2.06	38.91	25.56	0.29
Reach-1	18.8	90.00	100.41	103.23	101.89	103.30	0.001605	2.18	41.34	26.82	0.31
Reach-1	18.8	100.00	100.41	103.32	101.98	103.40	0.001738	2.29	43.74	28.02	0.32
Reach-1	18.8	200.00	100.41	104.01	102.69	104.14	0.002032	2.96	81.78	113.43	0.37
Reach-1	18.8	500.00	100.41	104.81	104.22	105.01	0.002480	4.08	237.43	275.35	0.43
Reach-1	18.8	750.00	100.41	105.16	104.72	105.39	0.002808	4.69	346.21	346.14	0.46
Reach-1	18.8	1000.00	100.41	105.43	105.02	105.67	0.003035	5.14	445.52	397.97	0.49
Reach-1	18.8	1500.00	100.41	105.82	105.50	106.08	0.003233	5.70	600.47	400.00	0.51
Reach-1	18.6*	10.00	100.70	102.15	101.15	102.16	0.000240	0.64	15.75	15.84	0.11
Reach-1	18.6*	20.00	100.70	102.37	101.35	102.39	0.000533	1.03	19.41	17.17	0.17
Reach-1	18.6*	30.00	100.70	102.53	101.51	102.56	0.000893	1.34	22.31	19.52	0.22
Reach-1	18.6*	40.00	100.70	102.67	101.65	102.71	0.001231	1.59	25.10	21.66	0.26
Reach-1	18.6*	50.00	100.70	102.79	101.77	102.84	0.001525	1.80	27.81	23.55	0.29
Reach-1	18.6*	60.00	100.70	102.89	101.87	102.95	0.001785	1.97	30.41	25.23	0.32
Reach-1	18.6*	70.00	100.70	102.99	101.97	103.06	0.002001	2.12	33.02	26.81	0.34
Reach-1	18.6*	80.00	100.70	103.09	102.07	103.17	0.002177	2.24	35.64	28.31	0.35
Reach-1	18.6*	90.00	100.70	103.18	102.15	103.27	0.002270	2.35	38.26	29.21	0.36
Reach-1	18.6*	100.00	100.70	103.27	102.23	103.36	0.002292	2.45	40.77	29.40	0.37
Reach-1	18.6*	200.00	100.70	103.95	102.95	104.10	0.002247	3.13	79.60	115.93	0.39
Reach-1	18.6*	500.00	100.70	104.75	104.27	104.96	0.002661	4.25	235.68	276.85	0.44
Reach-1	18.6*	750.00	100.70	105.10	104.71	105.33	0.002954	4.84	345.94	348.29	0.48
Reach-1	18.6*	1000.00	100.70	105.36	104.99	105.61	0.003226	5.32	441.36	397.20	0.50
Reach-1	18.6*	1500.00	100.70	105.74	105.45	106.01	0.003427	5.88	593.32	398.50	0.53
Reach-1	18.4*	10.00	101.00	102.14	101.45	102.15	0.000561	0.83	12.11	15.83	0.17
Reach-1	18.4*	20.00	101.00	102.35	101.64	102.37	0.001222	1.27	15.76	19.39	0.25
Reach-1	18.4*	30.00	101.00	102.49	101.80	102.53	0.001835	1.60	18.81	22.30	0.31
Reach-1	18.4*	40.00	101.00	102.62	101.92	102.67	0.002310	1.84	21.76	24.78	0.35
Reach-1	18.4*	50.00	101.00	102.73	102.03	102.80	0.002629	2.03	24.69	26.80	0.37
Reach-1	18.4*	60.00	101.00	102.84	102.13	102.91	0.002698	2.19	27.44	26.97	0.38
Reach-1	18.4*	70.00	101.00	102.93	102.24	103.02	0.002748	2.33	30.04	27.14	0.39
Reach-1	18.4*	80.00	101.00	103.02	102.34	103.12	0.002785	2.46	32.52	27.29	0.40
Reach-1	18.4*	90.00	101.00	103.11	102.43	103.21	0.002811	2.58	34.92	27.44	0.40
Reach-1	18.4*	100.00	101.00	103.19	102.50	103.31	0.002834	2.69	37.22	27.58	0.41
Reach-1	18.4*	200.00	101.00	103.88	103.01	104.05	0.002655	3.38	76.13	117.12	0.42
Reach-1	18.4*	500.00	101.00	104.68	104.29	104.90	0.002900	4.42	234.82	278.78	0.46
Reach-1	18.4*	750.00	101.00	105.03	104.69	105.27	0.003218	5.02	342.26	347.93	0.50
Reach-1	18.4*	1000.00	101.00	105.28	104.95	105.54	0.003446	5.48	438.85	396.49	0.52
Reach-1	18.4*	1500.00	101.00	105.66	105.39	105.93	0.003629	6.03	588.66	397.00	0.55
Reach-1	18.2*	10.00	101.29	102.11	101.74	102.13	0.001977	1.13	8.85	18.89	0.29
Reach-1	18.2*	20.00	101.29	102.30	101.91	102.33	0.003129	1.55	12.89	24.12	0.37
Reach-1	18.2*	30.00	101.29	102.43	102.05	102.48	0.003433	1.86	16.10	24.42	0.40
Reach-1	18.2*	40.00	101.29	102.54	102.17	102.61	0.003638	2.12	18.89	24.61	0.43
Reach-1	18.2*	50.00	101.29	102.65	102.27	102.73	0.003769	2.33	21.46	24.79	0.44
Reach-1	18.2*	60.00	101.29	102.74	102.33	102.84	0.003859	2.51	23.88	24.95	0.45
Reach-1	18.2*	70.00	101.29	102.84	102.40	102.95	0.003916	2.67	26.17	25.11	0.46
Reach-1	18.2*	80.00	101.29	102.92	102.46	103.05	0.003950	2.82	28.39	25.26	0.47
Reach-1	18.2*	90.00	101.29	103.01	102.51	103.14	0.003968	2.95	30.53	25.40	0.47
Reach-1	18.2*	100.00	101.29	103.09	102.57	103.24	0.003986	3.07	32.59	25.54	0.48
Reach-1	18.2*	200.00	101.29	103.77	103.04	103.99	0.003577	3.81	67.24	109.03	0.48
Reach-1	18.2*	500.00	101.29	104.60	104.30	104.84	0.003378	4.70	227.41	277.06	0.50
Reach-1	18.2*	750.00	101.29	104.93	104.66	105.19	0.003735	5.33	330.17	344.06	0.53

Reach-1	18.2*	1000.00	101.29	105.20	104.92	105.47	0.003848	5.71	429.68	394.39	0.55
Reach-1	18.2*	1500.00	101.29	105.58	105.32	105.85	0.003934	6.21	580.43	395.50	0.57
Reach-1	18	10.00	101.58	101.99	101.93	102.05	0.012536	1.87	5.34	21.45	0.66
Reach-1	18	20.00	101.58	102.14	102.04	102.22	0.010802	2.35	8.53	21.74	0.66
Reach-1	18	30.00	101.58	102.25	102.13	102.36	0.011027	2.76	10.87	21.95	0.69
Reach-1	18	40.00	101.58	102.34	102.21	102.49	0.011434	3.12	12.84	22.13	0.72
Reach-1	18	50.00	101.58	102.43	102.29	102.60	0.011083	3.36	14.89	22.31	0.72
Reach-1	18	60.00	101.58	102.52	102.36	102.71	0.010664	3.55	16.88	22.49	0.72
Reach-1	18	70.00	101.58	102.60	102.43	102.82	0.010211	3.71	18.85	22.66	0.72
Reach-1	18	80.00	101.58	102.69	102.49	102.92	0.009773	3.85	20.78	22.83	0.71
Reach-1	18	90.00	101.58	102.77	102.55	103.02	0.009374	3.97	22.68	22.99	0.70
Reach-1	18	100.00	101.58	102.85	102.61	103.11	0.009027	4.08	24.53	23.15	0.70
Reach-1	18	200.00	101.58	103.48	103.12	103.87	0.007718	5.01	43.80	65.53	0.69
Reach-1	18	500.00	101.58	104.38	104.30	104.74	0.005663	5.72	182.48	246.04	0.63
Reach-1	18	750.00	101.58	104.77	104.63	105.10	0.005073	5.97	297.11	327.15	0.61
Reach-1	18	1000.00	101.58	105.07	104.88	105.38	0.004845	6.21	401.53	386.49	0.61
Reach-1	18	1500.00	101.58	105.49	105.26	105.77	0.004424	6.44	566.56	394.00	0.59
Reach-1	17.8*	10.00	101.25	101.66	101.62	101.75	0.017563	2.36	4.23	15.51	0.80
Reach-1	17.8*	20.00	101.25	101.82	101.77	101.95	0.016492	2.88	6.96	18.10	0.82
Reach-1	17.8*	30.00	101.25	101.98	101.88	102.12	0.013898	3.02	9.93	21.12	0.78
Reach-1	17.8*	40.00	101.25	102.11	101.99	102.26	0.010857	3.09	12.96	22.08	0.71
Reach-1	17.8*	50.00	101.25	102.24	102.06	102.40	0.009165	3.18	15.73	22.45	0.67
Reach-1	17.8*	60.00	101.25	102.35	102.14	102.52	0.008316	3.30	18.20	22.78	0.65
Reach-1	17.8*	70.00	101.25	102.45	102.20	102.63	0.007705	3.40	20.57	23.09	0.64
Reach-1	17.8*	80.00	101.25	102.55	102.27	102.74	0.007244	3.50	22.85	23.38	0.62
Reach-1	17.8*	90.00	101.25	102.64	102.33	102.84	0.006887	3.59	25.05	23.66	0.62
Reach-1	17.8*	100.00	101.25	102.73	102.39	102.94	0.006612	3.68	27.17	23.93	0.61
Reach-1	17.8*	200.00	101.25	103.40	102.89	103.72	0.005864	4.54	47.72	65.55	0.61
Reach-1	17.8*	500.00	101.25	104.23	104.15	104.62	0.005558	5.74	172.51	234.22	0.63
Reach-1	17.8*	750.00	101.25	104.64	104.51	104.99	0.005042	6.04	285.01	316.93	0.62
Reach-1	17.8*	1000.00	101.25	104.94	104.77	105.28	0.004840	6.30	388.10	377.12	0.61
Reach-1	17.8*	1500.00	101.25	105.36	105.17	105.67	0.004489	6.58	554.38	395.00	0.60
Reach-1	17.6*	10.00	100.92	101.37	101.29	101.45	0.012937	2.26	4.42	13.72	0.70
Reach-1	17.6*	20.00	100.92	101.62	101.45	101.71	0.008495	2.45	8.15	16.30	0.61
Reach-1	17.6*	30.00	100.92	101.80	101.58	101.91	0.007366	2.65	11.32	18.10	0.59
Reach-1	17.6*	40.00	100.92	101.96	101.69	102.08	0.006857	2.77	14.45	20.50	0.58
Reach-1	17.6*	50.00	100.92	102.11	101.79	102.24	0.006186	2.83	17.65	22.37	0.56
Reach-1	17.6*	60.00	100.92	102.24	101.88	102.37	0.005626	2.93	20.49	22.93	0.55
Reach-1	17.6*	70.00	100.92	102.35	101.97	102.49	0.005287	3.03	23.13	23.41	0.54
Reach-1	17.6*	80.00	100.92	102.46	102.05	102.61	0.005055	3.12	25.63	23.86	0.53
Reach-1	17.6*	90.00	100.92	102.56	102.11	102.72	0.004884	3.21	28.02	24.28	0.53
Reach-1	17.6*	100.00	100.92	102.65	102.17	102.82	0.004759	3.30	30.31	24.68	0.52
Reach-1	17.6*	200.00	100.92	103.33	102.69	103.60	0.004522	4.12	52.80	70.30	0.54
Reach-1	17.6*	500.00	100.92	104.16	104.01	104.51	0.004745	5.42	179.22	237.19	0.59
Reach-1	17.6*	750.00	100.92	104.55	104.40	104.89	0.004629	5.87	286.91	316.18	0.60
Reach-1	17.6*	1000.00	100.92	104.84	104.66	105.18	0.004577	6.21	387.26	375.10	0.60
Reach-1	17.6*	1500.00	100.92	105.26	105.08	105.58	0.004349	6.56	552.94	396.00	0.60
Reach-1	17.4*	10.00	100.58	101.33	100.96	101.35	0.001954	1.25	8.01	14.61	0.30
Reach-1	17.4*	20.00	100.58	101.56	101.14	101.61	0.002584	1.70	11.74	16.50	0.36
Reach-1	17.4*	30.00	100.58	101.74	101.28	101.81	0.002981	2.03	14.81	17.84	0.39
Reach-1	17.4*	40.00	100.58	101.90	101.40	101.98	0.003307	2.26	17.71	19.57	0.42
Reach-1	17.4*	50.00	100.58	102.04	101.50	102.13	0.003545	2.42	20.70	21.80	0.44
Reach-1	17.4*	60.00	100.58	102.17	101.60	102.27	0.003544	2.54	23.58	22.94	0.44
Reach-1	17.4*	70.00	100.58	102.29	101.68	102.40	0.003518	2.66	26.30	23.73	0.45
Reach-1	17.4*	80.00	100.58	102.40	101.76	102.52	0.003490	2.77	28.89	24.34	0.45

Design Channel: Bankfull Discharge: 200 cfs; Slope = 0.0036 ft/ft

Profile Output Table - Standard Table 1
HEC-RAS Plan: q200s36i River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 705
Plans = 1
Profiles = 15

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	20	10.00	101.20	101.73	101.61	101.77	0.007694	1.64	6.10	20.82	0.53
Reach-1	20	20.00	101.20	101.90	101.74	101.97	0.006987	2.01	9.97	23.35	0.54
Reach-1	20	30.00	101.20	102.04	101.84	102.12	0.006667	2.28	13.17	24.59	0.55
Reach-1	20	40.00	101.20	102.16	101.93	102.25	0.006269	2.46	16.26	25.80	0.55
Reach-1	20	50.00	101.20	102.28	102.01	102.38	0.005795	2.59	19.32	26.70	0.54
Reach-1	20	60.00	101.20	102.38	102.07	102.50	0.005331	2.70	22.19	26.89	0.52
Reach-1	20	70.00	101.20	102.49	102.13	102.61	0.004973	2.80	24.96	27.06	0.51
Reach-1	20	80.00	101.20	102.58	102.20	102.71	0.004754	2.91	27.51	27.23	0.51
Reach-1	20	90.00	101.20	102.67	102.25	102.81	0.004573	3.00	29.97	27.38	0.51
Reach-1	20	100.00	101.20	102.76	102.30	102.90	0.004432	3.09	32.34	27.53	0.50
Reach-1	20	200.00	101.20	103.46	102.75	103.69	0.003955	3.84	52.05	28.75	0.50
Reach-1	20	500.00	101.20	104.52	104.07	104.86	0.003809	5.10	168.40	215.28	0.53
Reach-1	20	750.00	101.20	104.96	104.71	105.31	0.003700	5.53	284.46	305.64	0.54
Reach-1	20	1000.00	101.20	105.27	105.02	105.62	0.003744	5.91	388.38	368.18	0.55
Reach-1	20	1500.00	101.20	105.71	105.52	106.05	0.003710	6.35	561.08	399.00	0.56
Reach-1	19.8*	10.00	100.94	101.49	101.40	101.56	0.013439	2.20	4.55	15.19	0.71
Reach-1	19.8*	20.00	100.94	101.67	101.57	101.78	0.012585	2.60	7.70	19.00	0.72
Reach-1	19.8*	30.00	100.94	101.85	101.70	101.96	0.009710	2.65	11.30	22.15	0.65
Reach-1	19.8*	40.00	100.94	102.00	101.80	102.12	0.007507	2.68	14.92	23.68	0.60
Reach-1	19.8*	50.00	100.94	102.14	101.87	102.26	0.006497	2.75	18.21	25.00	0.57
Reach-1	19.8*	60.00	100.94	102.26	101.95	102.38	0.005894	2.81	21.33	26.20	0.55
Reach-1	19.8*	70.00	100.94	102.37	102.02	102.50	0.005475	2.87	24.39	27.50	0.54
Reach-1	19.8*	80.00	100.94	102.48	102.08	102.61	0.005001	2.93	27.28	27.72	0.52
Reach-1	19.8*	90.00	100.94	102.58	102.14	102.72	0.004662	3.00	30.01	27.89	0.51
Reach-1	19.8*	100.00	100.94	102.67	102.20	102.82	0.004438	3.07	32.56	28.04	0.50
Reach-1	19.8*	200.00	100.94	103.39	102.66	103.61	0.003786	3.77	53.09	29.26	0.49
Reach-1	19.8*	500.00	100.94	104.45	103.92	104.78	0.003685	5.02	169.65	215.36	0.52
Reach-1	19.8*	750.00	100.94	104.89	104.62	105.23	0.003642	5.49	283.98	304.47	0.53
Reach-1	19.8*	1000.00	100.94	105.20	104.94	105.54	0.003699	5.87	387.51	366.95	0.54
Reach-1	19.8*	1500.00	100.94	105.63	105.44	105.97	0.003703	6.34	559.08	399.16	0.56
Reach-1	19.6*	10.00	100.69	101.22	101.15	101.30	0.013049	2.29	4.36	13.31	0.71
Reach-1	19.6*	20.00	100.69	101.47	101.30	101.57	0.008543	2.55	7.85	14.74	0.62
Reach-1	19.6*	30.00	100.69	101.67	101.44	101.78	0.007540	2.74	10.94	16.71	0.60
Reach-1	19.6*	40.00	100.69	101.84	101.56	101.97	0.007335	2.83	14.11	20.08	0.60
Reach-1	19.6*	50.00	100.69	102.00	101.66	102.12	0.006643	2.86	17.47	22.74	0.58
Reach-1	19.6*	60.00	100.69	102.13	101.77	102.26	0.005902	2.90	20.71	24.19	0.55
Reach-1	19.6*	70.00	100.69	102.26	101.86	102.39	0.005435	2.94	23.79	25.48	0.54

Reach-1	19.6*	80.00	100.69	102.37	101.94	102.51	0.005099	2.99	26.77	26.68	0.53
Reach-1	19.6*	90.00	100.69	102.48	102.02	102.62	0.004857	3.03	29.66	27.83	0.52
Reach-1	19.6*	100.00	100.69	102.58	102.07	102.72	0.004600	3.08	32.43	28.47	0.51
Reach-1	19.6*	200.00	100.69	103.32	102.59	103.53	0.003679	3.71	53.95	29.75	0.49
Reach-1	19.6*	500.00	100.69	104.38	103.77	104.70	0.003572	4.94	171.81	216.78	0.51
Reach-1	19.6*	750.00	100.69	104.82	104.53	105.15	0.003563	5.42	285.82	305.41	0.53
Reach-1	19.6*	1000.00	100.69	105.12	104.86	105.46	0.003635	5.81	389.19	367.74	0.54
Reach-1	19.6*	1500.00	100.69	105.56	105.36	105.89	0.003646	6.28	561.05	399.34	0.55
Reach-1	19.4*	10.00	100.43	101.16	100.87	101.19	0.002611	1.40	7.15	13.54	0.34
Reach-1	19.4*	20.00	100.43	101.41	101.03	101.46	0.003003	1.87	10.67	14.30	0.38
Reach-1	19.4*	30.00	100.43	101.60	101.16	101.67	0.003533	2.23	13.48	15.71	0.42
Reach-1	19.4*	40.00	100.43	101.76	101.27	101.85	0.003841	2.48	16.13	16.98	0.45
Reach-1	19.4*	50.00	100.43	101.90	101.38	102.01	0.004277	2.67	18.72	19.11	0.48
Reach-1	19.4*	60.00	100.43	102.04	101.48	102.16	0.004598	2.80	21.45	21.60	0.49
Reach-1	19.4*	70.00	100.43	102.16	101.58	102.29	0.004614	2.88	24.29	23.46	0.50
Reach-1	19.4*	80.00	100.43	102.28	101.67	102.41	0.004487	2.95	27.12	24.74	0.50
Reach-1	19.4*	90.00	100.43	102.39	101.76	102.53	0.004390	3.01	29.85	25.92	0.50
Reach-1	19.4*	100.00	100.43	102.49	101.85	102.63	0.004310	3.08	32.52	27.02	0.49
Reach-1	19.4*	200.00	100.43	103.25	102.47	103.45	0.003594	3.65	54.77	30.25	0.48
Reach-1	19.4*	500.00	100.43	104.32	103.64	104.63	0.003398	4.82	177.26	221.01	0.50
Reach-1	19.4*	750.00	100.43	104.76	104.43	105.07	0.003407	5.30	292.43	308.92	0.51
Reach-1	19.4*	1000.00	100.43	105.06	104.77	105.39	0.003479	5.68	397.20	371.22	0.53
Reach-1	19.4*	1500.00	100.43	105.50	105.28	105.82	0.003508	6.16	568.94	399.50	0.54
Reach-1	19.2*	10.00	100.18	101.14	100.59	101.16	0.000751	0.95	10.56	13.86	0.19
Reach-1	19.2*	20.00	100.18	101.39	100.76	101.42	0.001249	1.42	14.05	14.47	0.25
Reach-1	19.2*	30.00	100.18	101.57	100.89	101.62	0.001726	1.79	16.72	15.45	0.30
Reach-1	19.2*	40.00	100.18	101.72	101.01	101.79	0.002109	2.08	19.20	16.44	0.34
Reach-1	19.2*	50.00	100.18	101.86	101.11	101.94	0.002425	2.33	21.50	17.31	0.37
Reach-1	19.2*	60.00	100.18	101.98	101.21	102.08	0.002779	2.53	23.70	18.62	0.40
Reach-1	19.2*	70.00	100.18	102.10	101.31	102.21	0.003164	2.69	25.98	20.53	0.42
Reach-1	19.2*	80.00	100.18	102.21	101.39	102.33	0.003446	2.82	28.36	22.35	0.44
Reach-1	19.2*	90.00	100.18	102.31	101.49	102.45	0.003616	2.92	30.78	23.85	0.45
Reach-1	19.2*	100.00	100.18	102.41	101.57	102.55	0.003696	3.01	33.19	25.00	0.46
Reach-1	19.2*	200.00	100.18	103.18	102.31	103.38	0.003601	3.62	55.18	30.69	0.48
Reach-1	19.2*	500.00	100.18	104.26	103.53	104.56	0.003325	4.74	180.02	223.07	0.49
Reach-1	19.2*	750.00	100.18	104.69	104.35	105.00	0.003344	5.22	295.49	310.51	0.51
Reach-1	19.2*	1000.00	100.18	105.00	104.68	105.32	0.003411	5.60	401.14	372.97	0.52
Reach-1	19.2*	1500.00	100.18	105.44	105.20	105.75	0.003452	6.08	572.45	399.66	0.53
Reach-1	19.*	10.00	99.92	101.14	100.32	101.14	0.000294	0.70	14.22	14.13	0.12
Reach-1	19.*	20.00	99.92	101.38	100.48	101.40	0.000603	1.13	17.69	14.64	0.18
Reach-1	19.*	30.00	99.92	101.55	100.61	101.59	0.000921	1.48	20.30	15.36	0.23
Reach-1	19.*	40.00	99.92	101.70	100.73	101.75	0.001218	1.76	22.67	16.19	0.26
Reach-1	19.*	50.00	99.92	101.84	100.84	101.90	0.001488	2.01	24.86	16.92	0.29
Reach-1	19.*	60.00	99.92	101.95	100.94	102.03	0.001735	2.23	26.90	17.57	0.32
Reach-1	19.*	70.00	99.92	102.06	101.03	102.16	0.001974	2.43	28.86	18.30	0.34
Reach-1	19.*	80.00	99.92	102.17	101.12	102.27	0.002292	2.59	30.84	19.83	0.37
Reach-1	19.*	90.00	99.92	102.26	101.21	102.38	0.002573	2.74	32.84	21.27	0.39
Reach-1	19.*	100.00	99.92	102.36	101.29	102.49	0.002817	2.87	34.88	22.65	0.41
Reach-1	19.*	200.00	99.92	103.11	102.01	103.31	0.003636	3.61	55.43	31.02	0.48
Reach-1	19.*	500.00	99.92	104.20	103.46	104.49	0.003260	4.66	183.32	226.00	0.49
Reach-1	19.*	750.00	99.92	104.63	104.27	104.93	0.003276	5.13	299.88	313.46	0.50
Reach-1	19.*	1000.00	99.92	104.94	104.60	105.25	0.003329	5.50	407.18	376.43	0.51
Reach-1	19.*	1500.00	99.92	105.38	105.12	105.68	0.003362	5.96	579.09	399.84	0.52
Reach-1	18.8	10.00	99.67	101.13	100.05	101.14	0.000144	0.56	17.86	14.35	0.09
Reach-1	18.8	20.00	99.67	101.37	100.21	101.39	0.000336	0.94	21.35	14.79	0.14

Reach-1	18.8	30.00	99.67	101.55	100.34	101.57	0.000547	1.25	23.92	15.34	0.18
Reach-1	18.8	40.00	99.67	101.69	100.46	101.73	0.000762	1.52	26.24	16.06	0.21
Reach-1	18.8	50.00	99.67	101.82	100.57	101.87	0.000970	1.76	28.35	16.69	0.24
Reach-1	18.8	60.00	99.67	101.94	100.67	102.00	0.001170	1.98	30.31	17.26	0.26
Reach-1	18.8	70.00	99.67	102.04	100.77	102.12	0.001360	2.18	32.17	17.78	0.29
Reach-1	18.8	80.00	99.67	102.14	100.86	102.23	0.001539	2.36	33.96	18.26	0.30
Reach-1	18.8	90.00	99.67	102.24	100.95	102.33	0.001770	2.52	35.68	19.28	0.33
Reach-1	18.8	100.00	99.67	102.32	101.03	102.43	0.002012	2.67	37.42	20.47	0.35
Reach-1	18.8	200.00	99.67	103.03	101.75	103.24	0.003562	3.61	55.43	30.15	0.47
Reach-1	18.8	500.00	99.67	104.14	103.41	104.42	0.003236	4.60	186.05	228.35	0.48
Reach-1	18.8	750.00	99.67	104.57	104.19	104.86	0.003237	5.05	303.72	315.81	0.49
Reach-1	18.8	1000.00	99.67	104.89	104.53	105.18	0.003269	5.40	412.69	379.22	0.50
Reach-1	18.8	1500.00	99.67	105.32	105.05	105.61	0.003300	5.85	584.71	400.00	0.51
Reach-1	18.6*	10.00	99.87	101.13	100.28	101.14	0.000263	0.68	14.79	14.39	0.12
Reach-1	18.6*	20.00	99.87	101.36	100.44	101.38	0.000577	1.10	18.20	15.28	0.18
Reach-1	18.6*	30.00	99.87	101.52	100.57	101.56	0.000909	1.44	20.78	16.25	0.23
Reach-1	18.6*	40.00	99.87	101.66	100.69	101.71	0.001214	1.73	23.10	17.07	0.26
Reach-1	18.6*	50.00	99.87	101.78	100.80	101.85	0.001499	1.98	25.22	17.79	0.29
Reach-1	18.6*	60.00	99.87	101.89	100.90	101.97	0.001855	2.21	27.21	19.23	0.33
Reach-1	18.6*	70.00	99.87	101.99	100.99	102.08	0.002205	2.40	29.22	20.81	0.36
Reach-1	18.6*	80.00	99.87	102.09	101.08	102.19	0.002516	2.56	31.26	22.30	0.38
Reach-1	18.6*	90.00	99.87	102.18	101.16	102.29	0.002790	2.70	33.28	23.66	0.40
Reach-1	18.6*	100.00	99.87	102.26	101.25	102.38	0.002988	2.83	35.31	24.68	0.42
Reach-1	18.6*	200.00	99.87	102.96	102.01	103.16	0.003615	3.62	55.32	30.86	0.48
Reach-1	18.6*	500.00	99.87	104.06	103.31	104.35	0.003238	4.67	183.15	225.83	0.49
Reach-1	18.6*	750.00	99.87	104.50	104.13	104.79	0.003250	5.14	300.36	313.79	0.50
Reach-1	18.6*	1000.00	99.87	104.81	104.47	105.11	0.003308	5.51	407.62	376.71	0.51
Reach-1	18.6*	1500.00	99.87	105.24	104.99	105.54	0.003364	5.99	578.31	399.75	0.52
Reach-1	18.4*	10.00	100.07	101.12	100.51	101.13	0.000585	0.86	11.66	14.78	0.17
Reach-1	18.4*	20.00	100.07	101.33	100.67	101.36	0.001156	1.33	15.07	16.48	0.24
Reach-1	18.4*	30.00	100.07	101.48	100.80	101.53	0.001737	1.70	17.65	18.04	0.30
Reach-1	18.4*	40.00	100.07	101.61	100.91	101.67	0.002349	1.99	20.12	20.43	0.35
Reach-1	18.4*	50.00	100.07	101.73	101.02	101.80	0.002853	2.22	22.57	22.54	0.39
Reach-1	18.4*	60.00	100.07	101.83	101.13	101.92	0.003163	2.41	24.93	23.75	0.41
Reach-1	18.4*	70.00	100.07	101.92	101.22	102.03	0.003396	2.57	27.23	24.79	0.43
Reach-1	18.4*	80.00	100.07	102.01	101.31	102.13	0.003575	2.71	29.51	25.78	0.45
Reach-1	18.4*	90.00	100.07	102.10	101.40	102.22	0.003727	2.84	31.73	26.70	0.46
Reach-1	18.4*	100.00	100.07	102.18	101.49	102.32	0.003838	2.95	33.96	27.60	0.47
Reach-1	18.4*	200.00	100.07	102.88	102.11	103.09	0.003628	3.66	54.61	30.24	0.48
Reach-1	18.4*	500.00	100.07	103.98	103.28	104.28	0.003271	4.75	181.81	225.13	0.49
Reach-1	18.4*	750.00	100.07	104.43	104.07	104.73	0.003224	5.19	301.88	315.04	0.50
Reach-1	18.4*	1000.00	100.07	104.73	104.41	105.04	0.003303	5.57	408.24	377.19	0.51
Reach-1	18.4*	1500.00	100.07	105.16	104.92	105.47	0.003359	6.05	578.78	399.50	0.53
Reach-1	18.2*	10.00	100.28	101.09	100.74	101.11	0.001937	1.18	8.46	16.62	0.29
Reach-1	18.2*	20.00	100.28	101.28	100.90	101.32	0.003179	1.64	12.18	21.16	0.38
Reach-1	18.2*	30.00	100.28	101.42	101.03	101.48	0.003814	1.98	15.19	22.87	0.43
Reach-1	18.2*	40.00	100.28	101.53	101.15	101.61	0.004179	2.23	17.93	24.04	0.46
Reach-1	18.2*	50.00	100.28	101.64	101.26	101.73	0.004430	2.44	20.49	25.08	0.48
Reach-1	18.2*	60.00	100.28	101.74	101.34	101.84	0.004603	2.61	22.95	26.04	0.49
Reach-1	18.2*	70.00	100.28	101.83	101.41	101.95	0.004699	2.76	25.39	27.00	0.50
Reach-1	18.2*	80.00	100.28	101.92	101.48	102.05	0.004736	2.87	27.84	27.96	0.51
Reach-1	18.2*	90.00	100.28	102.00	101.54	102.14	0.004607	2.98	30.24	28.13	0.51
Reach-1	18.2*	100.00	100.28	102.08	101.60	102.23	0.004486	3.07	32.57	28.27	0.50
Reach-1	18.2*	200.00	100.28	102.79	102.08	103.01	0.003837	3.77	53.04	29.48	0.50
Reach-1	18.2*	500.00	100.28	103.88	103.31	104.20	0.003552	4.94	173.42	218.55	0.51
Reach-1	18.2*	750.00	100.28	104.33	104.03	104.65	0.003464	5.37	291.59	309.23	0.52

Reach-1	18.2*	1000.00	100.28	104.65	104.35	104.97	0.003473	5.72	399.83	373.45	0.53
Reach-1	18.2*	1500.00	100.28	105.08	104.86	105.40	0.003496	6.18	571.26	399.25	0.54
Reach-1	18	10.00	100.48	100.97	100.89	101.03	0.011396	1.88	5.33	19.97	0.64
Reach-1	18	20.00	100.48	101.14	101.02	101.22	0.009688	2.23	8.97	22.96	0.63
Reach-1	18	30.00	100.48	101.26	101.12	101.36	0.009253	2.54	11.83	24.08	0.64
Reach-1	18	40.00	100.48	101.38	101.21	101.49	0.008568	2.73	14.65	25.14	0.63
Reach-1	18	50.00	100.48	101.48	101.29	101.61	0.008024	2.87	17.39	26.25	0.62
Reach-1	18	60.00	100.48	101.59	101.35	101.72	0.007289	2.98	20.14	26.75	0.60
Reach-1	18	70.00	100.48	101.69	101.41	101.83	0.006643	3.07	22.81	26.93	0.59
Reach-1	18	80.00	100.48	101.78	101.48	101.93	0.006177	3.16	25.35	27.09	0.57
Reach-1	18	90.00	100.48	101.87	101.53	102.03	0.005796	3.23	27.83	27.25	0.56
Reach-1	18	100.00	100.48	101.96	101.58	102.13	0.005490	3.31	30.24	27.40	0.55
Reach-1	18	200.00	100.48	102.69	102.04	102.93	0.004283	3.94	50.74	28.67	0.52
Reach-1	18	500.00	100.48	103.76	103.35	104.13	0.004113	5.25	159.82	207.04	0.55
Reach-1	18	750.00	100.48	104.21	103.99	104.57	0.003943	5.67	274.13	298.71	0.55
Reach-1	18	1000.00	100.48	104.54	104.31	104.89	0.003827	5.96	383.85	365.68	0.55
Reach-1	18	1500.00	100.48	104.99	104.80	105.32	0.003728	6.36	560.06	399.00	0.56
Reach-1	17.8*	10.00	100.22	100.71	100.64	100.78	0.013515	2.17	4.61	15.75	0.71
Reach-1	17.8*	20.00	100.22	100.88	100.79	100.99	0.013234	2.67	7.50	18.52	0.74
Reach-1	17.8*	30.00	100.22	101.04	100.91	101.16	0.010678	2.77	10.81	21.38	0.69
Reach-1	17.8*	40.00	100.22	101.20	101.01	101.32	0.008765	2.79	14.31	24.13	0.64
Reach-1	17.8*	50.00	100.22	101.34	101.09	101.46	0.007195	2.81	17.77	25.54	0.59
Reach-1	17.8*	60.00	100.22	101.46	101.17	101.59	0.006138	2.85	21.02	26.22	0.56
Reach-1	17.8*	70.00	100.22	101.58	101.25	101.71	0.005492	2.91	24.08	26.82	0.54
Reach-1	17.8*	80.00	100.22	101.68	101.31	101.82	0.005027	2.97	26.91	27.05	0.53
Reach-1	17.8*	90.00	100.22	101.78	101.36	101.92	0.004692	3.04	29.62	27.27	0.51
Reach-1	17.8*	100.00	100.22	101.88	101.42	102.03	0.004445	3.11	32.20	27.47	0.51
Reach-1	17.8*	200.00	100.22	102.63	101.88	102.85	0.003628	3.74	53.54	29.11	0.49
Reach-1	17.8*	500.00	100.22	103.69	102.99	104.04	0.003705	5.07	164.12	208.65	0.53
Reach-1	17.8*	750.00	100.22	104.15	103.88	104.50	0.003637	5.54	278.88	300.06	0.53
Reach-1	17.8*	1000.00	100.22	104.46	104.21	104.81	0.003691	5.92	382.50	363.34	0.55
Reach-1	17.8*	1500.00	100.22	104.90	104.72	105.25	0.003696	6.40	555.50	399.16	0.56
Reach-1	17.6*	10.00	99.97	100.47	100.38	100.54	0.010482	2.02	4.94	15.46	0.63
Reach-1	17.6*	20.00	99.97	100.72	100.53	100.79	0.006714	2.26	8.86	16.77	0.55
Reach-1	17.6*	30.00	99.97	100.91	100.65	101.00	0.005904	2.46	12.21	18.45	0.53
Reach-1	17.6*	40.00	99.97	101.07	100.75	101.18	0.005540	2.60	15.40	20.36	0.53
Reach-1	17.6*	50.00	99.97	101.22	100.85	101.33	0.005366	2.69	18.58	22.76	0.52
Reach-1	17.6*	60.00	99.97	101.36	100.93	101.47	0.005097	2.75	21.85	24.98	0.52
Reach-1	17.6*	70.00	99.97	101.48	101.02	101.60	0.004676	2.79	25.12	26.30	0.50
Reach-1	17.6*	80.00	99.97	101.60	101.10	101.72	0.004287	2.84	28.17	26.81	0.49
Reach-1	17.6*	90.00	99.97	101.70	101.18	101.83	0.004004	2.90	31.04	27.14	0.48
Reach-1	17.6*	100.00	99.97	101.80	101.25	101.94	0.003804	2.96	33.75	27.42	0.47
Reach-1	17.6*	200.00	99.97	102.57	101.75	102.77	0.003247	3.59	55.68	29.54	0.46
Reach-1	17.6*	500.00	99.97	103.64	102.78	103.96	0.003416	4.92	169.25	212.09	0.51
Reach-1	17.6*	750.00	99.97	104.08	103.78	104.42	0.003437	5.42	283.38	302.17	0.52
Reach-1	17.6*	1000.00	99.97	104.39	104.12	104.74	0.003547	5.84	385.66	364.46	0.54
Reach-1	17.6*	1500.00	99.97	104.83	104.64	105.17	0.003597	6.34	557.85	399.34	0.55
Reach-1	17.4*	10.00	99.71	100.42	100.11	100.45	0.002022	1.23	8.15	15.56	0.30
Reach-1	17.4*	20.00	99.71	100.67	100.26	100.71	0.002391	1.66	12.01	16.35	0.34
Reach-1	17.4*	30.00	99.71	100.85	100.38	100.91	0.002727	1.98	15.14	17.46	0.37
Reach-1	17.4*	40.00	99.71	101.01	100.49	101.09	0.002950	2.22	18.04	18.60	0.40
Reach-1	17.4*	50.00	99.71	101.15	100.59	101.24	0.003163	2.41	20.75	19.88	0.42
Reach-1	17.4*	60.00	99.71	101.28	100.67	101.39	0.003418	2.56	23.47	21.84	0.43
Reach-1	17.4*	70.00	99.71	101.41	100.76	101.52	0.003546	2.66	26.31	23.71	0.45
Reach-1	17.4*	80.00	99.71	101.52	100.85	101.64	0.003614	2.74	29.15	25.44	0.45

Reach-1	17.4*	90.00	99.71	101.63	100.93	101.76	0.003578	2.81	32.00	26.72	0.45
Reach-1	17.4*	100.00	99.71	101.74	101.01	101.86	0.003427	2.88	34.77	27.13	0.45
Reach-1	17.4*	200.00	99.71	102.52	101.64	102.71	0.003071	3.51	57.06	29.98	0.45
Reach-1	17.4*	500.00	99.71	103.59	102.68	103.89	0.003194	4.77	176.40	217.83	0.49
Reach-1	17.4*	750.00	99.71	104.03	103.68	104.34	0.003240	5.27	292.08	306.98	0.51
Reach-1	17.4*	1000.00	99.71	104.33	104.02	104.66	0.003368	5.69	394.98	368.59	0.52
Reach-1	17.4*	1500.00	99.71	104.77	104.55	105.10	0.003435	6.19	567.18	399.50	0.54
Reach-1	17.2*	10.00	99.46	100.41	99.85	100.42	0.000616	0.86	11.62	15.28	0.17
Reach-1	17.2*	20.00	99.46	100.65	100.00	100.67	0.001052	1.31	15.29	15.89	0.23
Reach-1	17.2*	30.00	99.46	100.83	100.13	100.87	0.001422	1.65	18.21	16.70	0.28
Reach-1	17.2*	40.00	99.46	100.98	100.24	101.04	0.001730	1.92	20.87	17.64	0.31
Reach-1	17.2*	50.00	99.46	101.12	100.34	101.19	0.001987	2.14	23.32	18.47	0.34
Reach-1	17.2*	60.00	99.46	101.24	100.43	101.33	0.002212	2.34	25.67	19.33	0.36
Reach-1	17.2*	70.00	99.46	101.36	100.52	101.46	0.002504	2.50	28.04	21.01	0.38
Reach-1	17.2*	80.00	99.46	101.47	100.60	101.58	0.002738	2.63	30.42	22.58	0.40
Reach-1	17.2*	90.00	99.46	101.57	100.68	101.69	0.002914	2.74	32.87	24.09	0.41
Reach-1	17.2*	100.00	99.46	101.67	100.76	101.80	0.003039	2.83	35.38	25.54	0.42
Reach-1	17.2*	200.00	99.46	102.46	101.46	102.65	0.003063	3.48	57.55	30.33	0.44
Reach-1	17.2*	500.00	99.46	103.53	102.61	103.82	0.003129	4.69	180.07	220.98	0.48
Reach-1	17.2*	750.00	99.46	103.97	103.60	104.28	0.003173	5.18	296.70	309.78	0.50
Reach-1	17.2*	1000.00	99.46	104.27	103.94	104.59	0.003301	5.60	400.16	371.17	0.51
Reach-1	17.2*	1500.00	99.46	104.71	104.48	105.03	0.003370	6.09	572.25	399.66	0.53
Reach-1	17.*	10.00	99.20	100.41	99.58	100.41	0.000267	0.67	14.88	14.85	0.12
Reach-1	17.*	20.00	99.20	100.64	99.74	100.66	0.000562	1.09	18.37	15.35	0.18
Reach-1	17.*	30.00	99.20	100.81	99.87	100.84	0.000845	1.42	21.09	15.96	0.22
Reach-1	17.*	40.00	99.20	100.96	99.98	101.01	0.001114	1.70	23.55	16.77	0.25
Reach-1	17.*	50.00	99.20	101.09	100.10	101.15	0.001359	1.94	25.80	17.48	0.28
Reach-1	17.*	60.00	99.20	101.21	100.19	101.29	0.001579	2.15	27.94	18.12	0.30
Reach-1	17.*	70.00	99.20	101.33	100.28	101.41	0.001773	2.33	30.00	18.73	0.32
Reach-1	17.*	80.00	99.20	101.43	100.37	101.53	0.002041	2.50	31.99	20.04	0.35
Reach-1	17.*	90.00	99.20	101.53	100.45	101.64	0.002289	2.64	34.04	21.42	0.37
Reach-1	17.*	100.00	99.20	101.62	100.53	101.74	0.002500	2.77	36.16	22.76	0.39
Reach-1	17.*	200.00	99.20	102.39	101.23	102.58	0.003226	3.51	57.06	30.53	0.45
Reach-1	17.*	500.00	99.20	103.47	102.59	103.76	0.003165	4.64	182.53	223.98	0.48
Reach-1	17.*	750.00	99.20	103.91	103.53	104.21	0.003164	5.10	301.20	313.38	0.49
Reach-1	17.*	1000.00	99.20	104.22	103.87	104.52	0.003266	5.50	406.49	375.27	0.51
Reach-1	17.*	1500.00	99.20	104.65	104.40	104.96	0.003307	5.96	579.49	399.84	0.52
Reach-1	16.8	10.00	98.95	100.40	99.33	100.41	0.000148	0.56	17.71	14.33	0.09
Reach-1	16.8	20.00	98.95	100.63	99.49	100.65	0.000352	0.95	21.02	14.75	0.14
Reach-1	16.8	30.00	98.95	100.80	99.62	100.83	0.000569	1.27	23.58	15.23	0.18
Reach-1	16.8	40.00	98.95	100.95	99.74	100.99	0.000792	1.55	25.86	15.94	0.21
Reach-1	16.8	50.00	98.95	101.08	99.85	101.13	0.001009	1.79	27.93	16.57	0.24
Reach-1	16.8	60.00	98.95	101.19	99.95	101.26	0.001214	2.01	29.89	17.14	0.27
Reach-1	16.8	70.00	98.95	101.30	100.05	101.38	0.001406	2.20	31.77	17.67	0.29
Reach-1	16.8	80.00	98.95	101.40	100.14	101.49	0.001592	2.39	33.53	18.15	0.31
Reach-1	16.8	90.00	98.95	101.49	100.22	101.59	0.001807	2.55	35.25	18.97	0.33
Reach-1	16.8	100.00	98.95	101.58	100.31	101.70	0.002052	2.70	37.00	20.19	0.35
Reach-1	16.8	200.00	98.95	102.31	101.03	102.51	0.003584	3.62	55.28	30.08	0.47
Reach-1	16.8	500.00	98.95	103.40	102.69	103.69	0.003353	4.66	181.79	224.55	0.49
Reach-1	16.8	750.00	98.95	103.85	103.47	104.14	0.003244	5.06	303.33	315.56	0.49
Reach-1	16.8	1000.00	98.95	104.16	103.81	104.45	0.003300	5.42	410.71	378.16	0.50
Reach-1	16.8	1500.00	98.95	104.60	104.33	104.89	0.003301	5.85	584.63	400.00	0.51
Reach-1	16.6*	10.00	99.15	100.40	99.54	100.41	0.000227	0.63	15.87	15.49	0.11
Reach-1	16.6*	20.00	99.15	100.62	99.69	100.64	0.000503	1.03	19.37	16.25	0.17
Reach-1	16.6*	30.00	99.15	100.79	99.82	100.81	0.000784	1.36	22.13	17.19	0.21

Reach-1	16.6*	40.00	99.15	100.93	99.93	100.97	0.001042	1.63	24.61	17.99	0.24
Reach-1	16.6*	50.00	99.15	101.05	100.03	101.10	0.001281	1.86	26.86	18.69	0.27
Reach-1	16.6*	60.00	99.15	101.16	100.13	101.23	0.001547	2.07	29.00	19.84	0.30
Reach-1	16.6*	70.00	99.15	101.27	100.22	101.34	0.001821	2.25	31.15	21.32	0.33
Reach-1	16.6*	80.00	99.15	101.36	100.30	101.45	0.002073	2.41	33.25	22.67	0.35
Reach-1	16.6*	90.00	99.15	101.45	100.39	101.55	0.002295	2.54	35.37	23.95	0.37
Reach-1	16.6*	100.00	99.15	101.54	100.46	101.65	0.002488	2.67	37.50	25.18	0.39
Reach-1	16.6*	200.00	99.15	102.25	101.17	102.44	0.003077	3.47	57.71	30.50	0.44
Reach-1	16.6*	500.00	99.15	103.34	102.41	103.62	0.003020	4.60	185.64	226.31	0.47
Reach-1	16.6*	750.00	99.15	103.79	103.38	104.07	0.003038	5.06	305.57	315.89	0.49
Reach-1	16.6*	1000.00	99.15	104.08	103.73	104.39	0.003199	5.49	408.30	376.02	0.51
Reach-1	16.6*	1500.00	99.15	104.51	104.26	104.82	0.003296	6.00	578.27	399.75	0.52
Reach-1	16.4*	10.00	99.35	100.39	99.75	100.40	0.000430	0.75	13.39	16.74	0.15
Reach-1	16.4*	20.00	99.35	100.60	99.90	100.62	0.000856	1.17	17.11	18.25	0.21
Reach-1	16.4*	30.00	99.35	100.76	100.02	100.79	0.001229	1.50	20.07	19.37	0.26
Reach-1	16.4*	40.00	99.35	100.89	100.13	100.94	0.001628	1.75	22.80	21.38	0.30
Reach-1	16.4*	50.00	99.35	101.01	100.23	101.07	0.001966	1.97	25.42	23.15	0.33
Reach-1	16.4*	60.00	99.35	101.12	100.31	101.19	0.002243	2.14	28.00	24.76	0.36
Reach-1	16.4*	70.00	99.35	101.22	100.40	101.30	0.002460	2.29	30.59	26.28	0.37
Reach-1	16.4*	80.00	99.35	101.31	100.49	101.41	0.002554	2.42	33.09	26.90	0.38
Reach-1	16.4*	90.00	99.35	101.40	100.57	101.50	0.002603	2.53	35.50	27.22	0.39
Reach-1	16.4*	100.00	99.35	101.49	100.64	101.60	0.002646	2.64	37.84	27.53	0.40
Reach-1	16.4*	200.00	99.35	102.20	101.27	102.38	0.002888	3.44	58.22	30.09	0.44
Reach-1	16.4*	500.00	99.35	103.28	102.32	103.56	0.002949	4.63	185.59	226.25	0.47
Reach-1	16.4*	750.00	99.35	103.71	103.32	104.01	0.003035	5.14	302.91	314.27	0.49
Reach-1	16.4*	1000.00	99.35	104.00	103.67	104.32	0.003227	5.60	403.72	373.70	0.51
Reach-1	16.4*	1500.00	99.35	104.42	104.21	104.75	0.003380	6.16	570.43	399.50	0.53
Reach-1	16.2*	10.00	99.56	100.37	99.97	100.38	0.001212	0.98	10.21	18.78	0.23
Reach-1	16.2*	20.00	99.56	100.57	100.12	100.60	0.001976	1.41	14.19	21.78	0.31
Reach-1	16.2*	30.00	99.56	100.71	100.24	100.76	0.002513	1.71	17.57	24.22	0.35
Reach-1	16.2*	40.00	99.56	100.84	100.34	100.90	0.002790	1.93	20.78	25.85	0.38
Reach-1	16.2*	50.00	99.56	100.95	100.43	101.02	0.002880	2.11	23.74	26.40	0.39
Reach-1	16.2*	60.00	99.56	101.06	100.52	101.14	0.002943	2.26	26.52	26.88	0.40
Reach-1	16.2*	70.00	99.56	101.16	100.60	101.25	0.002954	2.40	29.20	27.13	0.41
Reach-1	16.2*	80.00	99.56	101.25	100.68	101.35	0.002974	2.52	31.71	27.35	0.41
Reach-1	16.2*	90.00	99.56	101.34	100.75	101.45	0.002982	2.64	34.14	27.57	0.42
Reach-1	16.2*	100.00	99.56	101.42	100.81	101.54	0.002990	2.74	36.49	27.78	0.42
Reach-1	16.2*	200.00	99.56	102.13	101.27	102.32	0.003077	3.54	56.57	29.49	0.45
Reach-1	16.2*	500.00	99.56	103.20	102.31	103.49	0.003082	4.73	183.83	226.20	0.48
Reach-1	16.2*	750.00	99.56	103.64	103.28	103.94	0.003129	5.23	301.84	314.59	0.50
Reach-1	16.2*	1000.00	99.56	103.93	103.62	104.25	0.003303	5.67	403.27	374.23	0.52
Reach-1	16.2*	1500.00	99.56	104.35	104.14	104.68	0.003434	6.22	570.09	399.25	0.54
Reach-1	16	10.00	99.76	100.29	100.17	100.33	0.007650	1.64	6.11	20.84	0.53
Reach-1	16	20.00	99.76	100.47	100.30	100.53	0.006852	1.99	10.03	23.38	0.54
Reach-1	16	30.00	99.76	100.60	100.40	100.68	0.006582	2.27	13.23	24.61	0.55
Reach-1	16	40.00	99.76	100.72	100.49	100.82	0.006205	2.45	16.32	25.82	0.54
Reach-1	16	50.00	99.76	100.84	100.57	100.94	0.005743	2.58	19.37	26.70	0.53
Reach-1	16	60.00	99.76	100.95	100.63	101.06	0.005290	2.70	22.25	26.89	0.52
Reach-1	16	70.00	99.76	101.05	100.69	101.17	0.004940	2.80	25.01	27.07	0.51
Reach-1	16	80.00	99.76	101.14	100.76	101.27	0.004727	2.90	27.56	27.23	0.51
Reach-1	16	90.00	99.76	101.23	100.81	101.37	0.004548	3.00	30.02	27.39	0.50
Reach-1	16	100.00	99.76	101.32	100.86	101.47	0.004412	3.09	32.38	27.54	0.50
Reach-1	16	200.00	99.76	102.02	101.31	102.25	0.003941	3.84	52.11	28.75	0.50
Reach-1	16	500.00	99.76	103.08	102.63	103.42	0.003791	5.09	168.92	215.77	0.53
Reach-1	16	750.00	99.76	103.53	103.27	103.87	0.003690	5.53	284.89	305.92	0.54
Reach-1	16	1000.00	99.76	103.84	103.58	104.18	0.003728	5.90	389.27	368.68	0.55

Reach-1	16	1500.00	99.76	104.27	104.08	104.61	0.003696	6.34	561.96	399.00	0.55
Reach-1	15.8*	10.00	99.51	100.05	99.97	100.13	0.013315	2.19	4.57	15.26	0.70
Reach-1	15.8*	20.00	99.51	100.24	100.13	100.34	0.012792	2.61	7.67	19.03	0.72
Reach-1	15.8*	30.00	99.51	100.41	100.27	100.52	0.009833	2.66	11.26	22.16	0.66
Reach-1	15.8*	40.00	99.51	100.56	100.36	100.68	0.007566	2.69	14.88	23.70	0.60
Reach-1	15.8*	50.00	99.51	100.70	100.44	100.82	0.006539	2.75	18.18	25.01	0.57
Reach-1	15.8*	60.00	99.51	100.82	100.51	100.95	0.005923	2.82	21.30	26.21	0.55
Reach-1	15.8*	70.00	99.51	100.94	100.58	101.06	0.005500	2.87	24.37	27.51	0.54
Reach-1	15.8*	80.00	99.51	101.04	100.65	101.17	0.005019	2.94	27.25	27.72	0.52
Reach-1	15.8*	90.00	99.51	101.14	100.71	101.28	0.004676	3.00	29.99	27.89	0.51
Reach-1	15.8*	100.00	99.51	101.23	100.76	101.38	0.004450	3.07	32.53	28.04	0.50
Reach-1	15.8*	200.00	99.51	101.95	101.23	102.17	0.003788	3.77	53.08	29.26	0.49
Reach-1	15.8*	500.00	99.51	103.01	102.48	103.34	0.003671	5.01	170.27	215.99	0.52
Reach-1	15.8*	750.00	99.51	103.45	103.18	103.79	0.003626	5.48	284.87	305.10	0.53
Reach-1	15.8*	1000.00	99.51	103.76	103.50	104.10	0.003682	5.86	388.65	367.61	0.54
Reach-1	15.8*	1500.00	99.51	104.20	104.00	104.53	0.003681	6.32	560.54	399.16	0.55
Reach-1	15.6*	10.00	99.25	99.78	99.71	99.86	0.012403	2.26	4.43	13.33	0.69
Reach-1	15.6*	20.00	99.25	100.03	99.86	100.13	0.008395	2.53	7.89	14.77	0.61
Reach-1	15.6*	30.00	99.25	100.23	100.00	100.35	0.007434	2.73	11.00	16.75	0.59
Reach-1	15.6*	40.00	99.25	100.40	100.12	100.53	0.007258	2.82	14.18	20.15	0.59
Reach-1	15.6*	50.00	99.25	100.56	100.22	100.69	0.006573	2.85	17.54	22.77	0.57
Reach-1	15.6*	60.00	99.25	100.70	100.33	100.83	0.005851	2.89	20.78	24.21	0.55
Reach-1	15.6*	70.00	99.25	100.82	100.42	100.95	0.005396	2.93	23.85	25.51	0.53
Reach-1	15.6*	80.00	99.25	100.93	100.50	101.07	0.005068	2.98	26.83	26.70	0.52
Reach-1	15.6*	90.00	99.25	101.04	100.57	101.18	0.004830	3.03	29.72	27.85	0.52
Reach-1	15.6*	100.00	99.25	101.14	100.63	101.29	0.004570	3.08	32.50	28.47	0.51
Reach-1	15.6*	200.00	99.25	101.88	101.15	102.09	0.003664	3.70	54.01	29.75	0.48
Reach-1	15.6*	500.00	99.25	102.94	102.33	103.27	0.003548	4.93	172.61	217.53	0.51
Reach-1	15.6*	750.00	99.25	103.38	103.09	103.71	0.003541	5.41	286.85	306.09	0.52
Reach-1	15.6*	1000.00	99.25	103.69	103.42	104.03	0.003603	5.79	391.00	368.74	0.54
Reach-1	15.6*	1500.00	99.25	104.13	103.92	104.46	0.003614	6.26	563.04	399.34	0.55
Reach-1	15.4*	10.00	99.00	99.72	99.43	99.75	0.002700	1.41	7.08	13.54	0.34
Reach-1	15.4*	20.00	99.00	99.97	99.59	100.02	0.003094	1.89	10.57	14.29	0.39
Reach-1	15.4*	30.00	99.00	100.16	99.73	100.23	0.003614	2.24	13.39	15.71	0.43
Reach-1	15.4*	40.00	99.00	100.32	99.84	100.42	0.003915	2.49	16.04	16.98	0.45
Reach-1	15.4*	50.00	99.00	100.46	99.95	100.58	0.004350	2.68	18.63	19.12	0.48
Reach-1	15.4*	60.00	99.00	100.60	100.05	100.72	0.004666	2.81	21.36	21.61	0.50
Reach-1	15.4*	70.00	99.00	100.72	100.15	100.85	0.004672	2.89	24.20	23.46	0.50
Reach-1	15.4*	80.00	99.00	100.84	100.24	100.98	0.004539	2.96	27.02	24.74	0.50
Reach-1	15.4*	90.00	99.00	100.95	100.32	101.09	0.004436	3.02	29.75	25.92	0.50
Reach-1	15.4*	100.00	99.00	101.05	100.42	101.20	0.004353	3.08	32.42	27.02	0.50
Reach-1	15.4*	200.00	99.00	101.81	101.03	102.02	0.003610	3.66	54.69	30.23	0.48
Reach-1	15.4*	500.00	99.00	102.88	102.19	103.19	0.003458	4.85	174.89	218.95	0.51
Reach-1	15.4*	750.00	99.00	103.31	103.00	103.64	0.003479	5.34	288.71	306.76	0.52
Reach-1	15.4*	1000.00	99.00	103.62	103.33	103.95	0.003547	5.73	392.98	369.31	0.53
Reach-1	15.4*	1500.00	99.00	104.06	103.85	104.38	0.003575	6.20	564.57	399.50	0.54
Reach-1	15.2*	10.00	98.74	99.70	99.15	99.72	0.000743	0.94	10.60	13.87	0.19
Reach-1	15.2*	20.00	98.74	99.95	99.32	99.98	0.001245	1.42	14.06	14.48	0.25
Reach-1	15.2*	30.00	98.74	100.13	99.45	100.18	0.001719	1.79	16.74	15.46	0.30
Reach-1	15.2*	40.00	98.74	100.28	99.57	100.35	0.002102	2.08	19.22	16.45	0.34
Reach-1	15.2*	50.00	98.74	100.42	99.67	100.50	0.002417	2.32	21.53	17.32	0.37
Reach-1	15.2*	60.00	98.74	100.54	99.77	100.64	0.002773	2.53	23.73	18.65	0.39
Reach-1	15.2*	70.00	98.74	100.66	99.87	100.77	0.003157	2.69	26.01	20.55	0.42
Reach-1	15.2*	80.00	98.74	100.77	99.95	100.89	0.003438	2.82	28.39	22.37	0.44
Reach-1	15.2*	90.00	98.74	100.88	100.05	101.01	0.003607	2.92	30.81	23.87	0.45

Reach-1	15.2*	100.00	98.74	100.97	100.13	101.11	0.003688	3.01	33.22	25.02	0.46
Reach-1	15.2*	200.00	98.74	101.74	100.87	101.94	0.003586	3.62	55.25	30.69	0.48
Reach-1	15.2*	500.00	98.74	102.82	102.09	103.12	0.003313	4.73	180.46	223.46	0.49
Reach-1	15.2*	750.00	98.74	103.25	102.92	103.56	0.003339	5.22	295.75	310.68	0.51
Reach-1	15.2*	1000.00	98.74	103.57	103.24	103.88	0.003396	5.59	402.07	373.48	0.52
Reach-1	15.2*	1500.00	98.74	104.00	103.76	104.31	0.003437	6.06	573.47	399.66	0.53
Reach-1	15.*	10.00	98.49	99.70	98.88	99.71	0.000296	0.70	14.19	14.13	0.12
Reach-1	15.*	20.00	98.49	99.94	99.04	99.96	0.000609	1.13	17.65	14.64	0.18
Reach-1	15.*	30.00	98.49	100.11	99.18	100.15	0.000928	1.48	20.26	15.36	0.23
Reach-1	15.*	40.00	98.49	100.26	99.30	100.31	0.001226	1.77	22.63	16.19	0.26
Reach-1	15.*	50.00	98.49	100.40	99.42	100.46	0.001497	2.01	24.82	16.92	0.29
Reach-1	15.*	60.00	98.49	100.52	99.51	100.59	0.001745	2.23	26.86	17.58	0.32
Reach-1	15.*	70.00	98.49	100.62	99.60	100.72	0.001985	2.43	28.82	18.32	0.34
Reach-1	15.*	80.00	98.49	100.73	99.69	100.83	0.002305	2.60	30.79	19.84	0.37
Reach-1	15.*	90.00	98.49	100.83	99.77	100.94	0.002587	2.74	32.80	21.28	0.39
Reach-1	15.*	100.00	98.49	100.92	99.86	101.05	0.002830	2.87	34.84	22.65	0.41
Reach-1	15.*	200.00	98.49	101.67	100.58	101.87	0.003636	3.61	55.44	31.02	0.48
Reach-1	15.*	500.00	98.49	102.76	102.03	103.05	0.003252	4.66	183.79	226.47	0.49
Reach-1	15.*	750.00	98.49	103.19	102.83	103.49	0.003273	5.13	300.24	313.74	0.50
Reach-1	15.*	1000.00	98.49	103.51	103.16	103.81	0.003312	5.48	408.39	377.11	0.51
Reach-1	15.*	1500.00	98.49	103.94	103.69	104.24	0.003348	5.95	580.21	399.84	0.52
Reach-1	14.8	10.00	98.23	99.70	98.61	99.70	0.000143	0.56	17.90	14.35	0.09
Reach-1	14.8	20.00	98.23	99.93	98.77	99.95	0.000336	0.94	21.36	14.79	0.14
Reach-1	14.8	30.00	98.23	100.11	98.90	100.13	0.000546	1.25	23.95	15.35	0.18
Reach-1	14.8	40.00	98.23	100.25	99.02	100.29	0.000760	1.52	26.26	16.07	0.21
Reach-1	14.8	50.00	98.23	100.38	99.13	100.43	0.000968	1.76	28.37	16.70	0.24
Reach-1	14.8	60.00	98.23	100.50	99.23	100.56	0.001168	1.98	30.33	17.26	0.26
Reach-1	14.8	70.00	98.23	100.61	99.33	100.68	0.001357	2.17	32.19	17.78	0.28
Reach-1	14.8	80.00	98.23	100.70	99.42	100.79	0.001537	2.35	33.98	18.27	0.30
Reach-1	14.8	90.00	98.23	100.80	99.51	100.89	0.001769	2.52	35.70	19.29	0.33
Reach-1	14.8	100.00	98.23	100.88	99.59	100.99	0.002010	2.67	37.43	20.48	0.35
Reach-1	14.8	200.00	98.23	101.60	100.31	101.80	0.003550	3.60	55.51	30.19	0.47
Reach-1	14.8	500.00	98.23	102.70	101.97	102.98	0.003220	4.59	186.66	228.89	0.48
Reach-1	14.8	750.00	98.23	103.13	102.75	103.42	0.003230	5.05	304.10	316.05	0.49
Reach-1	14.8	1000.00	98.23	103.45	103.09	103.74	0.003249	5.39	414.01	379.92	0.50
Reach-1	14.8	1500.00	98.23	103.88	103.61	104.17	0.003280	5.84	586.05	400.00	0.51
Reach-1	14.6*	10.00	98.43	99.69	98.84	99.70	0.000261	0.67	14.83	14.40	0.12
Reach-1	14.6*	20.00	98.43	99.92	99.00	99.94	0.000576	1.10	18.22	15.29	0.18
Reach-1	14.6*	30.00	98.43	100.08	99.13	100.12	0.000906	1.44	20.80	16.25	0.22
Reach-1	14.6*	40.00	98.43	100.22	99.25	100.27	0.001211	1.73	23.13	17.08	0.26
Reach-1	14.6*	50.00	98.43	100.35	99.36	100.41	0.001495	1.98	25.24	17.79	0.29
Reach-1	14.6*	60.00	98.43	100.45	99.46	100.53	0.001852	2.20	27.24	19.25	0.33
Reach-1	14.6*	70.00	98.43	100.55	99.55	100.64	0.002201	2.39	29.25	20.83	0.36
Reach-1	14.6*	80.00	98.43	100.65	99.64	100.75	0.002511	2.56	31.28	22.32	0.38
Reach-1	14.6*	90.00	98.43	100.74	99.72	100.85	0.002785	2.70	33.31	23.68	0.40
Reach-1	14.6*	100.00	98.43	100.82	99.81	100.94	0.002983	2.83	35.34	24.69	0.42
Reach-1	14.6*	200.00	98.43	101.52	100.57	101.73	0.003595	3.61	55.42	30.87	0.47
Reach-1	14.6*	500.00	98.43	102.62	101.87	102.91	0.003217	4.66	183.96	226.55	0.48
Reach-1	14.6*	750.00	98.43	103.06	102.69	103.35	0.003239	5.14	300.91	314.15	0.50
Reach-1	14.6*	1000.00	98.43	103.37	103.03	103.67	0.003278	5.49	409.58	377.76	0.51
Reach-1	14.6*	1500.00	98.43	103.80	103.55	104.10	0.003335	5.97	580.25	399.75	0.52
Reach-1	14.4*	10.00	98.64	99.68	99.07	99.69	0.000597	0.86	11.59	14.79	0.17
Reach-1	14.4*	20.00	98.64	99.89	99.23	99.92	0.001182	1.34	14.97	16.48	0.25
Reach-1	14.4*	30.00	98.64	100.05	99.37	100.09	0.001770	1.71	17.55	18.04	0.31
Reach-1	14.4*	40.00	98.64	100.17	99.48	100.24	0.002389	2.00	20.02	20.43	0.36

Reach-1	14.4*	50.00	98.64	100.29	99.59	100.36	0.002897	2.23	22.46	22.54	0.39
Reach-1	14.4*	60.00	98.64	100.39	99.69	100.48	0.003209	2.42	24.81	23.74	0.42
Reach-1	14.4*	70.00	98.64	100.48	99.79	100.59	0.003443	2.58	27.12	24.78	0.43
Reach-1	14.4*	80.00	98.64	100.57	99.88	100.69	0.003622	2.72	29.39	25.77	0.45
Reach-1	14.4*	90.00	98.64	100.66	99.97	100.78	0.003775	2.85	31.60	26.69	0.46
Reach-1	14.4*	100.00	98.64	100.74	100.06	100.88	0.003885	2.96	33.82	27.58	0.47
Reach-1	14.4*	200.00	98.64	101.44	100.67	101.65	0.003640	3.67	54.54	30.22	0.48
Reach-1	14.4*	500.00	98.64	102.54	101.83	102.84	0.003351	4.79	178.59	222.36	0.50
Reach-1	14.4*	750.00	98.64	102.97	102.64	103.28	0.003345	5.26	295.30	311.08	0.51
Reach-1	14.4*	1000.00	98.64	103.29	102.97	103.60	0.003390	5.63	402.57	374.53	0.52
Reach-1	14.4*	1500.00	98.64	103.72	103.49	104.03	0.003447	6.11	572.73	399.50	0.53
Reach-1	14.2*	10.00	98.84	99.65	99.30	99.67	0.001906	1.17	8.51	16.66	0.29
Reach-1	14.2*	20.00	98.84	99.84	99.46	99.88	0.003175	1.64	12.19	21.16	0.38
Reach-1	14.2*	30.00	98.84	99.98	99.59	100.04	0.003799	1.97	15.21	22.88	0.43
Reach-1	14.2*	40.00	98.84	100.10	99.71	100.17	0.004166	2.23	17.95	24.05	0.45
Reach-1	14.2*	50.00	98.84	100.20	99.82	100.29	0.004420	2.44	20.51	25.09	0.48
Reach-1	14.2*	60.00	98.84	100.30	99.90	100.40	0.004594	2.61	22.97	26.05	0.49
Reach-1	14.2*	70.00	98.84	100.39	99.97	100.51	0.004692	2.76	25.41	27.00	0.50
Reach-1	14.2*	80.00	98.84	100.48	100.04	100.61	0.004732	2.87	27.85	27.96	0.51
Reach-1	14.2*	90.00	98.84	100.56	100.10	100.70	0.004606	2.98	30.24	28.13	0.51
Reach-1	14.2*	100.00	98.84	100.64	100.16	100.79	0.004487	3.07	32.57	28.27	0.50
Reach-1	14.2*	200.00	98.84	101.36	100.64	101.58	0.003813	3.76	53.15	29.49	0.49
Reach-1	14.2*	500.00	98.84	102.44	101.87	102.76	0.003545	4.94	173.64	218.76	0.51
Reach-1	14.2*	750.00	98.84	102.90	102.59	103.22	0.003430	5.35	293.22	310.30	0.52
Reach-1	14.2*	1000.00	98.84	103.21	102.91	103.53	0.003468	5.71	400.13	373.61	0.53
Reach-1	14.2*	1500.00	98.84	103.64	103.42	103.96	0.003490	6.18	571.66	399.25	0.54
Reach-1	14	10.00	99.04	99.54	99.45	99.59	0.010625	1.83	5.46	20.12	0.62
Reach-1	14	20.00	99.04	99.70	99.58	99.78	0.009585	2.22	9.00	22.97	0.63
Reach-1	14	30.00	99.04	99.83	99.68	99.92	0.009062	2.52	11.91	24.11	0.63
Reach-1	14	40.00	99.04	99.94	99.77	100.05	0.008450	2.72	14.72	25.16	0.63
Reach-1	14	50.00	99.04	100.05	99.85	100.17	0.007960	2.87	17.44	26.27	0.62
Reach-1	14	60.00	99.04	100.15	99.91	100.29	0.007242	2.97	20.18	26.76	0.60
Reach-1	14	70.00	99.04	100.25	99.97	100.39	0.006618	3.07	22.84	26.93	0.59
Reach-1	14	80.00	99.04	100.34	100.04	100.50	0.006165	3.15	25.37	27.09	0.57
Reach-1	14	90.00	99.04	100.43	100.09	100.59	0.005794	3.23	27.83	27.25	0.56
Reach-1	14	100.00	99.04	100.52	100.14	100.69	0.005491	3.31	30.23	27.40	0.55
Reach-1	14	200.00	99.04	101.26	100.59	101.50	0.004249	3.93	50.87	28.68	0.52
Reach-1	14	500.00	99.04	102.32	101.91	102.69	0.004100	5.24	160.14	207.36	0.55
Reach-1	14	750.00	99.04	102.78	102.55	103.14	0.003857	5.62	277.67	301.10	0.55
Reach-1	14	1000.00	99.04	103.10	102.86	103.45	0.003816	5.95	384.44	366.01	0.55
Reach-1	14	1500.00	99.04	103.55	103.36	103.88	0.003715	6.35	560.79	399.00	0.56
Reach-1	13.8*	10.00	98.79	99.27	99.20	99.34	0.014371	2.21	4.52	15.73	0.73
Reach-1	13.8*	20.00	98.79	99.44	99.35	99.55	0.013535	2.68	7.45	18.54	0.75
Reach-1	13.8*	30.00	98.79	99.60	99.47	99.72	0.010851	2.79	10.76	21.39	0.69
Reach-1	13.8*	40.00	98.79	99.76	99.58	99.88	0.008869	2.80	14.27	24.15	0.64
Reach-1	13.8*	50.00	98.79	99.90	99.66	100.02	0.007265	2.82	17.72	25.54	0.60
Reach-1	13.8*	60.00	98.79	100.02	99.74	100.15	0.006193	2.86	20.97	26.22	0.56
Reach-1	13.8*	70.00	98.79	100.14	99.81	100.27	0.005548	2.92	24.00	26.82	0.54
Reach-1	13.8*	80.00	98.79	100.24	99.87	100.38	0.005081	2.98	26.83	27.05	0.53
Reach-1	13.8*	90.00	98.79	100.34	99.93	100.48	0.004744	3.05	29.52	27.26	0.52
Reach-1	13.8*	100.00	98.79	100.43	99.98	100.58	0.004492	3.12	32.10	27.47	0.51
Reach-1	13.8*	200.00	98.79	101.19	100.45	101.41	0.003616	3.73	53.60	29.12	0.48
Reach-1	13.8*	500.00	98.79	102.26	101.58	102.60	0.003700	5.07	164.48	209.06	0.53
Reach-1	13.8*	750.00	98.79	102.71	102.44	103.06	0.003622	5.53	279.73	300.68	0.53
Reach-1	13.8*	1000.00	98.79	103.02	102.77	103.38	0.003678	5.91	383.45	363.91	0.55
Reach-1	13.8*	1500.00	98.79	103.46	103.28	103.81	0.003679	6.38	556.72	399.16	0.56

Reach-1	13.6*	10.00	98.53	99.04	98.94	99.10	0.010285	2.01	4.97	15.49	0.63
Reach-1	13.6*	20.00	98.53	99.28	99.09	99.36	0.006660	2.25	8.89	16.78	0.55
Reach-1	13.6*	30.00	98.53	99.47	99.21	99.56	0.005870	2.45	12.24	18.46	0.53
Reach-1	13.6*	40.00	98.53	99.63	99.31	99.74	0.005518	2.59	15.42	20.38	0.53
Reach-1	13.6*	50.00	98.53	99.78	99.41	99.89	0.005349	2.69	18.60	22.77	0.52
Reach-1	13.6*	60.00	98.53	99.92	99.49	100.03	0.005086	2.74	21.87	24.99	0.52
Reach-1	13.6*	70.00	98.53	100.04	99.58	100.16	0.004680	2.79	25.11	26.30	0.50
Reach-1	13.6*	80.00	98.53	100.16	99.66	100.28	0.004297	2.84	28.14	26.81	0.49
Reach-1	13.6*	90.00	98.53	100.26	99.74	100.39	0.004018	2.90	31.00	27.14	0.48
Reach-1	13.6*	100.00	98.53	100.36	99.81	100.50	0.003818	2.97	33.71	27.41	0.47
Reach-1	13.6*	200.00	98.53	101.14	100.31	101.34	0.003220	3.58	55.84	29.55	0.46
Reach-1	13.6*	500.00	98.53	102.20	101.34	102.52	0.003403	4.91	169.71	212.53	0.51
Reach-1	13.6*	750.00	98.53	102.64	102.34	102.98	0.003418	5.41	284.31	302.80	0.52
Reach-1	13.6*	1000.00	98.53	102.95	102.68	103.30	0.003525	5.82	386.98	365.19	0.54
Reach-1	13.6*	1500.00	98.53	103.39	103.20	103.73	0.003570	6.32	559.51	399.34	0.55
Reach-1	13.4*	10.00	98.28	98.98	98.68	99.01	0.002081	1.24	8.07	15.55	0.30
Reach-1	13.4*	20.00	98.28	99.23	98.83	99.27	0.002439	1.68	11.94	16.34	0.35
Reach-1	13.4*	30.00	98.28	99.41	98.95	99.47	0.002771	1.99	15.07	17.46	0.38
Reach-1	13.4*	40.00	98.28	99.57	99.05	99.65	0.002991	2.23	17.96	18.60	0.40
Reach-1	13.4*	50.00	98.28	99.71	99.16	99.80	0.003202	2.42	20.67	19.88	0.42
Reach-1	13.4*	60.00	98.28	99.84	99.24	99.95	0.003458	2.57	23.39	21.83	0.44
Reach-1	13.4*	70.00	98.28	99.97	99.33	100.08	0.003591	2.67	26.20	23.68	0.45
Reach-1	13.4*	80.00	98.28	100.08	99.41	100.20	0.003661	2.76	29.02	25.41	0.45
Reach-1	13.4*	90.00	98.28	100.19	99.49	100.31	0.003630	2.83	31.86	26.71	0.46
Reach-1	13.4*	100.00	98.28	100.29	99.57	100.42	0.003472	2.89	34.62	27.11	0.45
Reach-1	13.4*	200.00	98.28	101.08	100.20	101.27	0.003058	3.50	57.12	29.96	0.45
Reach-1	13.4*	500.00	98.28	102.14	101.24	102.45	0.003249	4.80	173.89	215.57	0.49
Reach-1	13.4*	750.00	98.28	102.58	102.25	102.91	0.003302	5.31	288.46	304.85	0.51
Reach-1	13.4*	1000.00	98.28	102.89	102.59	103.22	0.003440	5.74	390.19	366.32	0.53
Reach-1	13.4*	1500.00	98.28	103.32	103.12	103.66	0.003508	6.25	562.11	399.50	0.54
Reach-1	13.2*	10.00	98.02	98.97	98.41	98.98	0.000615	0.86	11.63	15.28	0.17
Reach-1	13.2*	20.00	98.02	99.21	98.56	99.23	0.001051	1.31	15.30	15.89	0.23
Reach-1	13.2*	30.00	98.02	99.39	98.69	99.43	0.001421	1.65	18.21	16.70	0.28
Reach-1	13.2*	40.00	98.02	99.54	98.80	99.60	0.001729	1.92	20.87	17.64	0.31
Reach-1	13.2*	50.00	98.02	99.68	98.90	99.75	0.001987	2.14	23.33	18.47	0.34
Reach-1	13.2*	60.00	98.02	99.80	98.99	99.89	0.002213	2.34	25.67	19.32	0.36
Reach-1	13.2*	70.00	98.02	99.92	99.08	100.01	0.002509	2.50	28.01	20.99	0.38
Reach-1	13.2*	80.00	98.02	100.03	99.16	100.13	0.002747	2.63	30.37	22.55	0.40
Reach-1	13.2*	90.00	98.02	100.13	99.24	100.25	0.002927	2.74	32.80	24.05	0.41
Reach-1	13.2*	100.00	98.02	100.23	99.32	100.36	0.003053	2.83	35.31	25.50	0.42
Reach-1	13.2*	200.00	98.02	101.02	100.02	101.21	0.003035	3.46	57.73	30.37	0.44
Reach-1	13.2*	500.00	98.02	102.09	101.17	102.38	0.003127	4.68	180.15	221.05	0.48
Reach-1	13.2*	750.00	98.02	102.53	102.16	102.84	0.003168	5.18	296.95	309.94	0.50
Reach-1	13.2*	1000.00	98.02	102.83	102.50	103.15	0.003301	5.60	400.14	371.16	0.51
Reach-1	13.2*	1500.00	98.02	103.27	103.04	103.59	0.003370	6.09	572.21	399.66	0.53
Reach-1	13.*	10.00	97.76	98.97	98.14	98.97	0.000267	0.67	14.89	14.85	0.12
Reach-1	13.*	20.00	97.76	99.20	98.30	99.22	0.000561	1.09	18.37	15.35	0.18
Reach-1	13.*	30.00	97.76	99.37	98.43	99.40	0.000845	1.42	21.10	15.96	0.22
Reach-1	13.*	40.00	97.76	99.52	98.54	99.57	0.001114	1.70	23.56	16.77	0.25
Reach-1	13.*	50.00	97.76	99.65	98.66	99.71	0.001359	1.94	25.81	17.48	0.28
Reach-1	13.*	60.00	97.76	99.77	98.75	99.85	0.001579	2.15	27.94	18.12	0.30
Reach-1	13.*	70.00	97.76	99.88	98.84	99.97	0.001777	2.33	29.98	18.72	0.33
Reach-1	13.*	80.00	97.76	99.99	98.93	100.08	0.002047	2.50	31.95	20.01	0.35
Reach-1	13.*	90.00	97.76	100.08	99.01	100.19	0.002298	2.65	33.98	21.38	0.37
Reach-1	13.*	100.00	97.76	100.18	99.09	100.30	0.002509	2.77	36.09	22.72	0.39

Reach-1	13.*	200.00	97.76	100.96	99.79	101.15	0.003193	3.49	57.27	30.58	0.45
Reach-1	13.*	500.00	97.76	102.03	101.15	102.32	0.003162	4.64	182.63	224.07	0.48
Reach-1	13.*	750.00	97.76	102.47	102.09	102.77	0.003158	5.10	301.51	313.58	0.49
Reach-1	13.*	1000.00	97.76	102.78	102.43	103.08	0.003266	5.50	406.48	375.27	0.51
Reach-1	13.*	1500.00	97.76	103.21	102.96	103.52	0.003308	5.96	579.43	399.84	0.52
Reach-1	12.8	10.00	97.51	98.96	97.89	98.97	0.000148	0.56	17.71	14.33	0.09
Reach-1	12.8	20.00	97.51	99.19	98.05	99.21	0.000352	0.95	21.02	14.75	0.14
Reach-1	12.8	30.00	97.51	99.36	98.18	99.39	0.000568	1.27	23.58	15.23	0.18
Reach-1	12.8	40.00	97.51	99.51	98.30	99.55	0.000792	1.55	25.86	15.95	0.21
Reach-1	12.8	50.00	97.51	99.64	98.41	99.69	0.001009	1.79	27.93	16.57	0.24
Reach-1	12.8	60.00	97.51	99.75	98.51	99.82	0.001215	2.01	29.88	17.14	0.27
Reach-1	12.8	70.00	97.51	99.86	98.61	99.94	0.001409	2.21	31.75	17.66	0.29
Reach-1	12.8	80.00	97.51	99.96	98.70	100.05	0.001597	2.39	33.49	18.14	0.31
Reach-1	12.8	90.00	97.51	100.05	98.78	100.15	0.001812	2.56	35.19	18.93	0.33
Reach-1	12.8	100.00	97.51	100.14	98.87	100.25	0.002058	2.71	36.94	20.15	0.35
Reach-1	12.8	200.00	97.51	100.88	99.59	101.08	0.003549	3.60	55.52	30.19	0.47
Reach-1	12.8	500.00	97.51	101.96	101.25	102.25	0.003350	4.66	181.92	224.66	0.49
Reach-1	12.8	750.00	97.51	102.41	102.03	102.70	0.003237	5.05	303.71	315.80	0.49
Reach-1	12.8	1000.00	97.51	102.72	102.37	103.01	0.003300	5.42	410.70	378.16	0.51
Reach-1	12.8	1500.00	97.51	103.16	102.89	103.45	0.003302	5.85	584.56	400.00	0.51
Reach-1	12.6*	10.00	97.71	98.96	98.10	98.97	0.000227	0.63	15.87	15.49	0.11
Reach-1	12.6*	20.00	97.71	99.18	98.25	99.20	0.000503	1.03	19.37	16.25	0.17
Reach-1	12.6*	30.00	97.71	99.35	98.38	99.37	0.000783	1.36	22.14	17.19	0.21
Reach-1	12.6*	40.00	97.71	99.49	98.49	99.53	0.001041	1.63	24.62	17.99	0.24
Reach-1	12.6*	50.00	97.71	99.61	98.59	99.66	0.001281	1.86	26.86	18.69	0.27
Reach-1	12.6*	60.00	97.71	99.72	98.69	99.79	0.001547	2.07	28.99	19.84	0.30
Reach-1	12.6*	70.00	97.71	99.82	98.78	99.90	0.001825	2.25	31.12	21.30	0.33
Reach-1	12.6*	80.00	97.71	99.92	98.86	100.01	0.002081	2.41	33.20	22.64	0.35
Reach-1	12.6*	90.00	97.71	100.01	98.95	100.11	0.002306	2.55	35.29	23.91	0.37
Reach-1	12.6*	100.00	97.71	100.10	99.02	100.21	0.002501	2.67	37.42	25.14	0.39
Reach-1	12.6*	200.00	97.71	100.82	99.73	101.01	0.003038	3.45	57.97	30.55	0.44
Reach-1	12.6*	500.00	97.71	101.90	100.97	102.18	0.003017	4.59	185.79	226.44	0.47
Reach-1	12.6*	750.00	97.71	102.35	101.94	102.64	0.003029	5.06	306.08	316.22	0.48
Reach-1	12.6*	1000.00	97.71	102.64	102.29	102.95	0.003199	5.49	408.31	376.02	0.51
Reach-1	12.6*	1500.00	97.71	103.07	102.82	103.38	0.003298	6.00	578.17	399.75	0.52
Reach-1	12.4*	10.00	97.92	98.95	98.32	98.96	0.000437	0.75	13.33	16.74	0.15
Reach-1	12.4*	20.00	97.92	99.16	98.47	99.18	0.000867	1.17	17.05	18.25	0.21
Reach-1	12.4*	30.00	97.92	99.32	98.59	99.35	0.001242	1.50	20.00	19.37	0.26
Reach-1	12.4*	40.00	97.92	99.45	98.69	99.50	0.001643	1.76	22.73	21.38	0.30
Reach-1	12.4*	50.00	97.92	99.57	98.80	99.63	0.001983	1.97	25.35	23.14	0.33
Reach-1	12.4*	60.00	97.92	99.68	98.88	99.75	0.002263	2.15	27.91	24.75	0.36
Reach-1	12.4*	70.00	97.92	99.78	98.97	99.86	0.002489	2.30	30.46	26.24	0.38
Reach-1	12.4*	80.00	97.92	99.87	99.05	99.96	0.002592	2.43	32.93	26.89	0.39
Reach-1	12.4*	90.00	97.92	99.96	99.13	100.06	0.002643	2.55	35.33	27.21	0.39
Reach-1	12.4*	100.00	97.92	100.04	99.21	100.15	0.002685	2.66	37.66	27.51	0.40
Reach-1	12.4*	200.00	97.92	100.77	99.84	100.95	0.002858	3.42	58.43	30.12	0.43
Reach-1	12.4*	500.00	97.92	101.83	100.88	102.12	0.002958	4.63	185.40	226.14	0.47
Reach-1	12.4*	750.00	97.92	102.27	101.89	102.57	0.003024	5.13	303.73	314.85	0.49
Reach-1	12.4*	1000.00	97.92	102.56	102.23	102.88	0.003232	5.60	403.58	373.66	0.51
Reach-1	12.4*	1500.00	97.92	102.98	102.76	103.31	0.003386	6.16	570.21	399.50	0.53
Reach-1	12.2*	10.00	98.12	98.93	98.53	98.94	0.001212	0.98	10.21	18.78	0.23
Reach-1	12.2*	20.00	98.12	99.13	98.68	99.16	0.001976	1.41	14.19	21.78	0.31
Reach-1	12.2*	30.00	98.12	99.27	98.80	99.32	0.002513	1.71	17.57	24.22	0.35
Reach-1	12.2*	40.00	98.12	99.40	98.90	99.46	0.002791	1.93	20.78	25.85	0.38
Reach-1	12.2*	50.00	98.12	99.51	98.99	99.58	0.002883	2.11	23.73	26.40	0.39

Reach-1	12.2*	60.00	98.12	99.62	99.08	99.70	0.002950	2.26	26.50	26.88	0.40
Reach-1	12.2*	70.00	98.12	99.72	99.16	99.81	0.002977	2.40	29.13	27.12	0.41
Reach-1	12.2*	80.00	98.12	99.81	99.24	99.91	0.003006	2.53	31.60	27.34	0.41
Reach-1	12.2*	90.00	98.12	99.89	99.31	100.00	0.003017	2.65	34.02	27.56	0.42
Reach-1	12.2*	100.00	98.12	99.98	99.37	100.10	0.003024	2.75	36.36	27.76	0.42
Reach-1	12.2*	200.00	98.12	100.70	99.83	100.89	0.003024	3.52	56.89	29.52	0.45
Reach-1	12.2*	500.00	98.12	101.76	100.87	102.05	0.003080	4.73	183.92	226.28	0.48
Reach-1	12.2*	750.00	98.12	102.20	101.84	102.50	0.003125	5.22	302.09	314.74	0.50
Reach-1	12.2*	1000.00	98.12	102.49	102.18	102.81	0.003304	5.67	403.18	374.18	0.52
Reach-1	12.2*	1500.00	98.12	102.91	102.70	103.24	0.003437	6.22	569.88	399.25	0.54
Reach-1	12	10.00	98.32	98.85	98.73	98.89	0.001641	1.64	6.11	20.84	0.53
Reach-1	12	20.00	98.32	99.03	98.86	99.09	0.006853	1.99	10.03	23.38	0.54
Reach-1	12	30.00	98.32	99.16	98.96	99.24	0.006581	2.27	13.23	24.61	0.55
Reach-1	12	40.00	98.32	99.28	99.05	99.38	0.006208	2.45	16.32	25.82	0.54
Reach-1	12	50.00	98.32	99.40	99.13	99.50	0.005757	2.58	19.36	26.70	0.53
Reach-1	12	60.00	98.32	99.50	99.19	99.62	0.005318	2.70	22.21	26.89	0.52
Reach-1	12	70.00	98.32	99.60	99.25	99.73	0.005012	2.81	24.90	27.06	0.52
Reach-1	12	80.00	98.32	99.70	99.32	99.83	0.004818	2.92	27.39	27.22	0.51
Reach-1	12	90.00	98.32	99.79	99.37	99.93	0.004639	3.02	29.84	27.38	0.51
Reach-1	12	100.00	98.32	99.87	99.42	100.02	0.004494	3.11	32.20	27.53	0.51
Reach-1	12	200.00	98.32	100.59	99.87	100.82	0.003850	3.81	52.50	28.78	0.50
Reach-1	12	500.00	98.32	101.64	101.19	101.98	0.003787	5.09	169.06	215.90	0.53
Reach-1	12	750.00	98.32	102.09	101.83	102.43	0.003694	5.53	284.72	305.81	0.54
Reach-1	12	1000.00	98.32	102.39	102.14	102.74	0.003731	5.90	389.12	368.59	0.55
Reach-1	12	1500.00	98.32	102.83	102.64	103.17	0.003702	6.34	561.61	399.00	0.56
Reach-1	11.8*	10.00	98.07	98.61	98.53	98.68	0.013752	2.21	4.52	15.22	0.72
Reach-1	11.8*	20.00	98.07	98.80	98.69	98.90	0.012782	2.61	7.67	19.04	0.72
Reach-1	11.8*	30.00	98.07	98.97	98.83	99.08	0.009816	2.66	11.27	22.16	0.66
Reach-1	11.8*	40.00	98.07	99.12	98.92	99.24	0.007583	2.69	14.87	23.69	0.60
Reach-1	11.8*	50.00	98.07	99.26	99.00	99.38	0.006575	2.76	18.14	24.99	0.57
Reach-1	11.8*	60.00	98.07	99.38	99.07	99.50	0.005978	2.83	21.23	26.18	0.55
Reach-1	11.8*	70.00	98.07	99.49	99.14	99.62	0.005630	2.90	24.17	27.43	0.54
Reach-1	11.8*	80.00	98.07	99.59	99.21	99.73	0.005182	2.96	26.98	27.71	0.53
Reach-1	11.8*	90.00	98.07	99.69	99.27	99.83	0.004820	3.03	29.71	27.87	0.52
Reach-1	11.8*	100.00	98.07	99.78	99.32	99.93	0.004565	3.10	32.27	28.03	0.51
Reach-1	11.8*	200.00	98.07	100.52	99.79	100.74	0.003687	3.74	53.55	29.29	0.49
Reach-1	11.8*	500.00	98.07	101.57	101.04	101.90	0.003665	5.01	170.44	216.15	0.52
Reach-1	11.8*	750.00	98.07	102.01	101.74	102.35	0.003632	5.48	284.61	304.93	0.53
Reach-1	11.8*	1000.00	98.07	102.32	102.06	102.66	0.003686	5.86	388.39	367.46	0.54
Reach-1	11.8*	1500.00	98.07	102.75	102.56	103.09	0.003690	6.33	559.95	399.16	0.55
Reach-1	11.6*	10.00	97.81	98.34	98.27	98.42	0.012575	2.27	4.41	13.32	0.69
Reach-1	11.6*	20.00	97.81	98.59	98.42	98.69	0.008355	2.53	7.91	14.78	0.61
Reach-1	11.6*	30.00	97.81	98.79	98.56	98.91	0.007392	2.72	11.02	16.76	0.59
Reach-1	11.6*	40.00	97.81	98.96	98.68	99.09	0.007288	2.83	14.15	20.12	0.59
Reach-1	11.6*	50.00	97.81	99.12	98.78	99.24	0.006651	2.86	17.47	22.74	0.58
Reach-1	11.6*	60.00	97.81	99.25	98.89	99.38	0.005945	2.90	20.66	24.16	0.55
Reach-1	11.6*	70.00	97.81	99.37	98.98	99.51	0.005598	2.97	23.54	25.38	0.54
Reach-1	11.6*	80.00	97.81	99.48	99.06	99.62	0.005291	3.03	26.42	26.54	0.53
Reach-1	11.6*	90.00	97.81	99.59	99.13	99.73	0.005022	3.07	29.31	27.69	0.53
Reach-1	11.6*	100.00	97.81	99.69	99.19	99.84	0.004745	3.11	32.12	28.45	0.52
Reach-1	11.6*	200.00	97.81	100.46	99.71	100.67	0.003551	3.67	54.56	29.79	0.48
Reach-1	11.6*	500.00	97.81	101.50	100.89	101.83	0.003541	4.92	172.83	217.73	0.51
Reach-1	11.6*	750.00	97.81	101.94	101.65	102.27	0.003548	5.41	286.50	305.86	0.53
Reach-1	11.6*	1000.00	97.81	102.25	101.98	102.59	0.003610	5.80	390.62	368.53	0.54
Reach-1	11.6*	1500.00	97.81	102.68	102.49	103.01	0.003627	6.27	562.25	399.34	0.55

Reach-1	11.4*	10.00	97.56	98.27	97.99	98.31	0.002745	1.42	7.04	13.53	0.35
Reach-1	11.4*	20.00	97.56	98.53	98.15	98.59	0.003078	1.89	10.59	14.30	0.39
Reach-1	11.4*	30.00	97.56	98.72	98.29	98.80	0.003593	2.24	13.42	15.72	0.43
Reach-1	11.4*	40.00	97.56	98.88	98.40	98.97	0.003933	2.50	16.01	16.97	0.45
Reach-1	11.4*	50.00	97.56	99.02	98.51	99.13	0.004389	2.70	18.55	19.04	0.48
Reach-1	11.4*	60.00	97.56	99.15	98.61	99.28	0.004734	2.83	21.22	21.49	0.50
Reach-1	11.4*	70.00	97.56	99.27	98.71	99.40	0.004884	2.94	23.80	23.27	0.51
Reach-1	11.4*	80.00	97.56	99.38	98.80	99.52	0.004776	3.02	26.51	24.51	0.51
Reach-1	11.4*	90.00	97.56	99.49	98.88	99.64	0.004652	3.08	29.23	25.70	0.51
Reach-1	11.4*	100.00	97.56	99.59	98.98	99.74	0.004532	3.13	31.93	26.82	0.51
Reach-1	11.4*	200.00	97.56	100.39	99.59	100.59	0.003481	3.62	55.32	30.27	0.47
Reach-1	11.4*	500.00	97.56	101.44	100.75	101.75	0.003450	4.85	175.15	219.20	0.50
Reach-1	11.4*	750.00	97.56	101.87	101.56	102.20	0.003488	5.35	288.26	306.46	0.52
Reach-1	11.4*	1000.00	97.56	102.18	101.89	102.51	0.003557	5.73	392.42	369.00	0.53
Reach-1	11.4*	1500.00	97.56	102.61	102.41	102.94	0.003592	6.22	563.46	399.50	0.55
Reach-1	11.2*	10.00	97.30	98.26	97.71	98.28	0.000752	0.95	10.56	13.86	0.19
Reach-1	11.2*	20.00	97.30	98.51	97.88	98.54	0.001240	1.42	14.08	14.48	0.25
Reach-1	11.2*	30.00	97.30	98.69	98.01	98.74	0.001711	1.79	16.77	15.47	0.30
Reach-1	11.2*	40.00	97.30	98.84	98.13	98.91	0.002111	2.08	19.19	16.44	0.34
Reach-1	11.2*	50.00	97.30	98.98	98.23	99.06	0.002442	2.33	21.45	17.29	0.37
Reach-1	11.2*	60.00	97.30	99.10	98.33	99.20	0.002802	2.54	23.60	18.53	0.40
Reach-1	11.2*	70.00	97.30	99.20	98.43	99.32	0.003254	2.73	25.62	20.24	0.43
Reach-1	11.2*	80.00	97.30	99.31	98.51	99.43	0.003577	2.87	27.86	21.98	0.45
Reach-1	11.2*	90.00	97.30	99.41	98.61	99.55	0.003779	2.98	30.24	23.59	0.46
Reach-1	11.2*	100.00	97.30	99.51	98.69	99.66	0.003841	3.06	32.69	24.77	0.47
Reach-1	11.2*	200.00	97.30	100.32	99.43	100.52	0.003440	3.57	55.99	30.75	0.47
Reach-1	11.2*	500.00	97.30	101.38	100.65	101.68	0.003304	4.73	180.79	223.76	0.49
Reach-1	11.2*	750.00	97.30	101.81	101.47	102.12	0.003350	5.23	295.19	310.32	0.51
Reach-1	11.2*	1000.00	97.30	102.12	101.80	102.44	0.003408	5.60	401.32	373.07	0.52
Reach-1	11.2*	1500.00	97.30	102.55	102.33	102.87	0.003457	6.08	572.13	399.66	0.53
Reach-1	11.*	10.00	97.04	98.26	97.44	98.26	0.000294	0.70	14.21	14.13	0.12
Reach-1	11.*	20.00	97.04	98.50	97.60	98.52	0.000600	1.13	17.73	14.64	0.18
Reach-1	11.*	30.00	97.04	98.68	97.73	98.71	0.000915	1.47	20.35	15.38	0.23
Reach-1	11.*	40.00	97.04	98.82	97.85	98.87	0.001219	1.76	22.67	16.19	0.26
Reach-1	11.*	50.00	97.04	98.95	97.96	99.02	0.001497	2.02	24.80	16.90	0.29
Reach-1	11.*	60.00	97.04	99.07	98.06	99.15	0.001752	2.24	26.80	17.54	0.32
Reach-1	11.*	70.00	97.04	99.17	98.15	99.26	0.002018	2.45	28.53	18.07	0.34
Reach-1	11.*	80.00	97.04	99.26	98.24	99.37	0.002357	2.63	30.37	19.48	0.37
Reach-1	11.*	90.00	97.04	99.36	98.33	99.48	0.002653	2.78	32.33	20.91	0.39
Reach-1	11.*	100.00	97.04	99.46	98.41	99.59	0.002899	2.91	34.39	22.32	0.41
Reach-1	11.*	200.00	97.04	100.26	99.13	100.45	0.003453	3.55	56.38	31.13	0.46
Reach-1	11.*	500.00	97.04	101.33	100.58	101.61	0.003235	4.65	184.27	226.84	0.48
Reach-1	11.*	750.00	97.04	101.75	101.39	102.05	0.003283	5.14	299.51	313.23	0.50
Reach-1	11.*	1000.00	97.04	102.06	101.72	102.37	0.003325	5.49	407.39	376.54	0.51
Reach-1	11.*	1500.00	97.04	102.50	102.24	102.80	0.003369	5.96	578.66	399.84	0.52
Reach-1	10.8	10.00	96.79	98.25	97.17	98.26	0.000144	0.56	17.86	14.35	0.09
Reach-1	10.8	20.00	96.79	98.50	97.33	98.51	0.000335	0.94	21.39	14.80	0.14
Reach-1	10.8	30.00	96.79	98.67	97.46	98.69	0.000544	1.25	23.98	15.36	0.18
Reach-1	10.8	40.00	96.79	98.81	97.58	98.85	0.000762	1.52	26.23	16.06	0.21
Reach-1	10.8	50.00	96.79	98.94	97.69	98.99	0.000975	1.77	28.30	16.68	0.24
Reach-1	10.8	60.00	96.79	99.05	97.79	99.11	0.001180	1.99	30.21	17.23	0.26
Reach-1	10.8	70.00	96.79	99.15	97.89	99.22	0.001397	2.20	31.84	17.69	0.29
Reach-1	10.8	80.00	96.79	99.24	97.98	99.33	0.001593	2.39	33.52	18.14	0.31
Reach-1	10.8	90.00	96.79	99.33	98.07	99.43	0.001810	2.56	35.21	18.95	0.33
Reach-1	10.8	100.00	96.79	99.42	98.15	99.53	0.002056	2.71	36.96	20.16	0.35
Reach-1	10.8	200.00	96.79	100.19	98.87	100.38	0.003413	3.54	56.48	30.62	0.46

Reach-1	10.8	500.00	96.79	101.27	100.53	101.54	0.003205	4.58	187.20	229.37	0.48
Reach-1	10.8	750.00	96.79	101.69	101.31	101.98	0.003245	5.06	303.26	315.52	0.49
Reach-1	10.8	1000.00	96.79	102.01	101.65	102.30	0.003265	5.40	412.94	379.36	0.50
Reach-1	10.8	1500.00	96.79	102.44	102.17	102.73	0.003307	5.86	584.23	400.00	0.52
Reach-1	10.6*	10.00	96.99	98.25	97.40	98.26	0.000263	0.68	14.79	14.39	0.12
Reach-1	10.6*	20.00	96.99	98.48	97.56	98.50	0.000574	1.10	18.24	15.30	0.18
Reach-1	10.6*	30.00	96.99	98.65	97.69	98.68	0.000902	1.44	20.84	16.27	0.22
Reach-1	10.6*	40.00	96.99	98.78	97.81	98.83	0.001215	1.73	23.10	17.07	0.26
Reach-1	10.6*	50.00	96.99	98.90	97.92	98.96	0.001509	1.99	25.16	17.76	0.29
Reach-1	10.6*	60.00	96.99	99.01	98.02	99.08	0.001871	2.22	27.09	19.13	0.33
Reach-1	10.6*	70.00	96.99	99.09	98.11	99.18	0.002270	2.43	28.79	20.48	0.36
Reach-1	10.6*	80.00	96.99	99.18	98.20	99.29	0.002618	2.61	30.65	21.87	0.39
Reach-1	10.6*	90.00	96.99	99.27	98.28	99.39	0.002914	2.76	32.62	23.24	0.41
Reach-1	10.6*	100.00	96.99	99.35	98.37	99.48	0.003122	2.88	34.68	24.37	0.43
Reach-1	10.6*	200.00	96.99	100.12	99.13	100.32	0.003378	3.54	56.55	30.97	0.46
Reach-1	10.6*	500.00	96.99	101.19	100.43	101.47	0.003198	4.65	184.67	227.18	0.48
Reach-1	10.6*	750.00	96.99	101.61	101.25	101.91	0.003262	5.15	299.71	313.37	0.50
Reach-1	10.6*	1000.00	96.99	101.93	101.59	102.23	0.003302	5.51	408.02	376.92	0.51
Reach-1	10.6*	1500.00	96.99	102.35	102.11	102.66	0.003374	6.00	577.60	399.75	0.53
Reach-1	10.4*	10.00	97.19	98.24	97.63	98.25	0.000593	0.86	11.61	14.76	0.17
Reach-1	10.4*	20.00	97.19	98.46	97.79	98.48	0.001159	1.33	15.06	16.49	0.24
Reach-1	10.4*	30.00	97.19	98.61	97.92	98.65	0.001738	1.70	17.67	18.10	0.30
Reach-1	10.4*	40.00	97.19	98.73	98.04	98.79	0.002373	1.99	20.05	20.40	0.35
Reach-1	10.4*	50.00	97.19	98.84	98.14	98.92	0.002905	2.23	22.40	22.44	0.39
Reach-1	10.4*	60.00	97.19	98.94	98.25	99.03	0.003255	2.43	24.67	23.65	0.42
Reach-1	10.4*	70.00	97.19	99.02	98.35	99.13	0.003648	2.64	26.52	24.49	0.45
Reach-1	10.4*	80.00	97.19	99.10	98.44	99.22	0.003907	2.80	28.56	25.38	0.47
Reach-1	10.4*	90.00	97.19	99.18	98.53	99.32	0.004072	2.93	30.71	26.29	0.48
Reach-1	10.4*	100.00	97.19	99.27	98.62	99.41	0.004156	3.03	32.97	27.22	0.49
Reach-1	10.4*	200.00	97.19	100.05	99.23	100.25	0.003362	3.58	55.94	30.31	0.46
Reach-1	10.4*	500.00	97.19	101.10	100.38	101.40	0.003307	4.77	180.02	223.60	0.49
Reach-1	10.4*	750.00	97.19	101.53	101.20	101.84	0.003374	5.28	293.67	309.98	0.51
Reach-1	10.4*	1000.00	97.19	101.84	101.53	102.16	0.003424	5.65	400.27	373.26	0.52
Reach-1	10.4*	1500.00	97.19	102.27	102.05	102.59	0.003509	6.16	568.62	399.50	0.54
Reach-1	10.2*	10.00	97.40	98.20	97.86	98.23	0.001942	1.18	8.46	16.62	0.29
Reach-1	10.2*	20.00	97.40	98.41	98.02	98.45	0.003137	1.63	12.25	21.23	0.38
Reach-1	10.2*	30.00	97.40	98.54	98.15	98.60	0.003730	1.96	15.31	22.92	0.42
Reach-1	10.2*	40.00	97.40	98.65	98.27	98.73	0.004199	2.24	17.90	24.02	0.46
Reach-1	10.2*	50.00	97.40	98.75	98.38	98.85	0.004540	2.46	20.32	25.01	0.48
Reach-1	10.2*	60.00	97.40	98.84	98.46	98.95	0.004795	2.65	22.63	25.91	0.50
Reach-1	10.2*	70.00	97.40	98.91	98.53	99.04	0.005309	2.88	24.32	26.56	0.53
Reach-1	10.2*	80.00	97.40	98.98	98.60	99.13	0.005513	3.03	26.38	27.39	0.54
Reach-1	10.2*	90.00	97.40	99.07	98.66	99.22	0.005449	3.14	28.69	28.04	0.55
Reach-1	10.2*	100.00	97.40	99.16	98.72	99.32	0.005152	3.21	31.19	28.19	0.54
Reach-1	10.2*	200.00	97.40	99.97	99.20	100.18	0.003486	3.66	54.69	29.58	0.47
Reach-1	10.2*	500.00	97.40	101.01	100.43	101.33	0.003498	4.91	175.22	220.22	0.51
Reach-1	10.2*	750.00	97.40	101.45	101.15	101.77	0.003490	5.39	290.31	308.40	0.52
Reach-1	10.2*	1000.00	97.40	101.76	101.47	102.09	0.003531	5.76	396.31	371.53	0.53
Reach-1	10.2*	1500.00	97.40	102.19	101.98	102.51	0.003590	6.25	565.32	399.25	0.55
Reach-1	10	10.00	97.60	98.01	98.01	98.12	0.031474	2.65	3.78	18.13	1.02
Reach-1	10	20.00	97.60	98.14	98.14	98.30	0.027370	3.15	6.35	21.10	1.01
Reach-1	10	30.00	97.60	98.24	98.24	98.43	0.025572	3.52	8.52	22.78	1.01
Reach-1	10	40.00	97.60	98.33	98.33	98.55	0.023077	3.77	10.60	23.60	0.99
Reach-1	10	50.00	97.60	98.41	98.41	98.66	0.022268	4.03	12.40	24.30	0.99
Reach-1	10	60.00	97.60	98.47	98.47	98.76	0.022211	4.29	13.98	24.89	1.01

Reach-1	10	70.00	97.60	98.61	98.54	98.86	0.015266	3.98	17.57	26.32	0.86
Reach-1	10	80.00	97.60	98.75	98.60	98.97	0.010817	3.76	21.30	26.83	0.74
Reach-1	10	90.00	97.60	98.87	98.66	99.08	0.008686	3.67	24.53	27.04	0.68
Reach-1	10	100.00	97.60	98.99	98.70	99.19	0.007189	3.60	27.79	27.25	0.63
Reach-1	10	200.00	97.60	99.88	99.15	100.10	0.003799	3.79	52.73	28.79	0.49
Reach-1	10	500.00	97.60	100.89	100.47	101.25	0.004021	5.20	162.32	209.47	0.55
Reach-1	10	750.00	97.60	101.32	101.11	101.69	0.004018	5.71	271.13	296.67	0.56
Reach-1	10	1000.00	97.60	101.64	101.42	102.01	0.003970	6.05	376.45	361.56	0.56
Reach-1	10	1500.00	97.60	102.08	101.92	102.43	0.003929	6.50	548.49	399.00	0.57

Design Channel: Bankfull Discharge = 200 cfs; Slope = 0.0041 ft/ft

Profile Output Table - Standard Table 1
HEC-RAS Plan: q200sp41 River: RIVER-1 Reach: Reach-1

Rivers = 1
Hydraulic Reaches = 1
River Stations = 706
Plans = 1
Profiles = 15

Reach	River Sta	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Reach-1	20	10.00	101.90	102.40	102.32	102.46	0.011201	1.87	5.35	19.89	0.64
Reach-1	20	20.00	101.90	102.58	102.45	102.65	0.009305	2.18	9.19	23.63	0.62
Reach-1	20	30.00	101.90	102.70	102.55	102.80	0.008692	2.45	12.25	25.05	0.62
Reach-1	20	40.00	101.90	102.81	102.64	102.92	0.008221	2.68	14.94	25.56	0.62
Reach-1	20	50.00	101.90	102.91	102.71	103.04	0.007699	2.86	17.50	25.75	0.61
Reach-1	20	60.00	101.90	103.00	102.78	103.14	0.007290	3.01	19.92	25.93	0.61
Reach-1	20	70.00	101.90	103.09	102.84	103.25	0.006989	3.15	22.21	26.10	0.60
Reach-1	20	80.00	101.90	103.18	102.89	103.34	0.006672	3.27	24.49	26.26	0.60
Reach-1	20	90.00	101.90	103.26	102.95	103.44	0.006418	3.37	26.69	26.42	0.59
Reach-1	20	100.00	101.90	103.34	103.00	103.53	0.006222	3.47	28.79	26.57	0.59
Reach-1	20	200.00	101.90	104.00	103.46	104.28	0.005454	4.29	46.61	27.81	0.58
Reach-1	20	500.00	101.90	104.98	104.83	105.40	0.005119	5.63	153.77	207.83	0.61
Reach-1	20	750.00	101.90	105.42	105.30	105.82	0.004742	6.00	264.53	297.04	0.60
Reach-1	20	1000.00	101.90	105.76	105.58	106.13	0.004413	6.20	375.10	364.96	0.59
Reach-1	20	1500.00	101.90	106.19	106.04	106.54	0.004235	6.58	546.34	399.00	0.59
Reach-1	19.8*	10.00	101.60	102.11	102.05	102.20	0.015688	2.38	4.20	14.01	0.77
Reach-1	19.8*	20.00	101.60	102.28	102.21	102.41	0.015638	2.88	6.93	17.25	0.80
Reach-1	19.8*	30.00	101.60	102.45	102.35	102.58	0.012994	2.97	10.11	20.92	0.75
Reach-1	19.8*	40.00	101.60	102.59	102.44	102.73	0.010452	3.00	13.33	23.01	0.69
Reach-1	19.8*	50.00	101.60	102.73	102.53	102.87	0.008845	3.02	16.56	24.94	0.65
Reach-1	19.8*	60.00	101.60	102.85	102.61	102.99	0.007775	3.06	19.62	26.28	0.62
Reach-1	19.8*	70.00	101.60	102.96	102.68	103.11	0.006907	3.12	22.46	26.68	0.60
Reach-1	19.8*	80.00	101.60	103.06	102.74	103.21	0.006277	3.18	25.14	26.87	0.58
Reach-1	19.8*	90.00	101.60	103.15	102.81	103.31	0.005868	3.26	27.64	27.04	0.57
Reach-1	19.8*	100.00	101.60	103.23	102.86	103.41	0.005595	3.34	29.97	27.20	0.56
Reach-1	19.8*	200.00	101.60	103.91	103.31	104.17	0.004770	4.09	48.91	28.47	0.55
Reach-1	19.8*	500.00	101.60	104.91	104.67	105.30	0.004664	5.45	157.08	208.59	0.58
Reach-1	19.8*	750.00	101.60	105.33	105.18	105.72	0.004563	5.94	263.04	294.14	0.59
Reach-1	19.8*	1000.00	101.60	105.65	105.48	106.03	0.004421	6.24	367.01	358.78	0.59
Reach-1	19.8*	1500.00	101.60	106.09	105.95	106.45	0.004264	6.64	539.16	399.00	0.59
Reach-1	19.6*	10.00	101.30	101.80	101.74	101.89	0.015276	2.48	4.04	12.40	0.76
Reach-1	19.6*	20.00	101.30	102.05	101.91	102.16	0.009809	2.69	7.45	14.44	0.66
Reach-1	19.6*	30.00	101.30	102.24	102.04	102.37	0.008543	2.87	10.44	16.45	0.64
Reach-1	19.6*	40.00	101.30	102.41	102.16	102.55	0.008043	2.99	13.37	18.90	0.63
Reach-1	19.6*	50.00	101.30	102.56	102.27	102.71	0.007570	3.04	16.43	21.63	0.62
Reach-1	19.6*	60.00	101.30	102.70	102.37	102.85	0.006870	3.07	19.56	23.60	0.59
Reach-1	19.6*	70.00	101.30	102.82	102.47	102.97	0.006404	3.10	22.55	25.36	0.58
Reach-1	19.6*	80.00	101.30	102.94	102.55	103.09	0.005984	3.14	25.49	26.78	0.57

Reach-1	19.6*	90.00	101.30	103.04	102.62	103.20	0.005573	3.18	28.31	27.60	0.55
Reach-1	19.6*	100.00	101.30	103.13	102.69	103.30	0.005185	3.23	30.93	27.78	0.54
Reach-1	19.6*	200.00	101.30	103.84	103.19	104.08	0.004275	3.92	51.02	29.14	0.52
Reach-1	19.6*	500.00	101.30	104.84	104.52	105.20	0.004268	5.27	161.95	211.52	0.56
Reach-1	19.6*	750.00	101.30	105.25	105.08	105.63	0.004295	5.80	267.00	295.66	0.58
Reach-1	19.6*	1000.00	101.30	105.57	105.38	105.94	0.004219	6.13	370.54	359.84	0.58
Reach-1	19.6*	1500.00	101.30	105.99	105.86	106.36	0.004231	6.63	536.58	399.00	0.59
Reach-1	19.4*	10.00	101.01	101.73	101.43	101.76	0.002746	1.45	6.92	13.00	0.35
Reach-1	19.4*	20.00	101.01	101.98	101.60	102.04	0.003326	1.93	10.36	14.47	0.40
Reach-1	19.4*	30.00	101.01	102.17	101.75	102.25	0.003784	2.28	13.17	15.76	0.44
Reach-1	19.4*	40.00	101.01	102.33	101.88	102.43	0.004116	2.53	15.78	17.08	0.46
Reach-1	19.4*	50.00	101.01	102.47	101.98	102.58	0.004501	2.74	18.26	18.82	0.49
Reach-1	19.4*	60.00	101.01	102.60	102.08	102.73	0.004850	2.87	20.90	21.23	0.51
Reach-1	19.4*	70.00	101.01	102.72	102.19	102.86	0.004902	2.97	23.59	22.97	0.52
Reach-1	19.4*	80.00	101.01	102.83	102.27	102.98	0.004877	3.04	26.29	24.56	0.52
Reach-1	19.4*	90.00	101.01	102.94	102.36	103.09	0.004829	3.11	28.97	26.04	0.52
Reach-1	19.4*	100.00	101.01	103.04	102.45	103.19	0.004751	3.16	31.62	27.30	0.52
Reach-1	19.4*	200.00	101.01	103.77	103.07	103.99	0.003963	3.79	52.74	29.83	0.50
Reach-1	19.4*	500.00	101.01	104.77	104.37	105.11	0.003921	5.07	168.98	216.63	0.54
Reach-1	19.4*	750.00	101.01	105.19	104.96	105.54	0.003956	5.60	276.84	300.93	0.55
Reach-1	19.4*	1000.00	101.01	105.50	105.27	105.85	0.003986	5.97	378.32	362.77	0.56
Reach-1	19.4*	1500.00	101.01	105.92	105.76	106.27	0.004040	6.49	543.93	399.00	0.58
Reach-1	19.2*	10.00	100.71	101.72	101.11	101.73	0.000728	0.95	10.54	13.53	0.19
Reach-1	19.2*	20.00	100.71	101.96	101.29	101.99	0.001280	1.43	13.95	14.62	0.26
Reach-1	19.2*	30.00	100.71	102.14	101.44	102.19	0.001758	1.80	16.65	15.66	0.31
Reach-1	19.2*	40.00	100.71	102.29	101.57	102.36	0.002167	2.09	19.11	16.75	0.35
Reach-1	19.2*	50.00	100.71	102.42	101.68	102.51	0.002511	2.34	21.38	17.70	0.38
Reach-1	19.2*	60.00	100.71	102.55	101.79	102.65	0.002897	2.54	23.60	19.20	0.40
Reach-1	19.2*	70.00	100.71	102.66	101.89	102.77	0.003258	2.71	25.87	20.96	0.43
Reach-1	19.2*	80.00	100.71	102.77	101.98	102.89	0.003511	2.84	28.22	22.56	0.45
Reach-1	19.2*	90.00	100.71	102.87	102.07	103.00	0.003685	2.94	30.58	23.98	0.46
Reach-1	19.2*	100.00	100.71	102.96	102.16	103.11	0.003816	3.04	32.94	25.32	0.47
Reach-1	19.2*	200.00	100.71	103.70	102.88	103.91	0.003753	3.69	54.21	30.48	0.49
Reach-1	19.2*	500.00	100.71	104.71	104.24	105.03	0.003701	4.93	173.93	220.03	0.52
Reach-1	19.2*	750.00	100.71	105.13	104.86	105.46	0.003724	5.43	284.51	305.05	0.54
Reach-1	19.2*	1000.00	100.71	105.43	105.17	105.77	0.003837	5.85	383.63	364.80	0.55
Reach-1	19.2*	1500.00	100.71	105.84	105.67	106.19	0.003934	6.38	547.94	399.00	0.57
Reach-1	19.*	10.00	100.41	101.71	100.80	101.72	0.000287	0.71	14.18	13.85	0.12
Reach-1	19.*	20.00	100.41	101.95	100.99	101.97	0.000617	1.14	17.57	14.75	0.18
Reach-1	19.*	30.00	100.41	102.13	101.14	102.16	0.000946	1.48	20.21	15.65	0.23
Reach-1	19.*	40.00	100.41	102.27	101.27	102.32	0.001259	1.77	22.57	16.57	0.27
Reach-1	19.*	50.00	100.41	102.40	101.39	102.46	0.001548	2.02	24.72	17.36	0.30
Reach-1	19.*	60.00	100.41	102.52	101.50	102.59	0.001807	2.24	26.77	18.09	0.32
Reach-1	19.*	70.00	100.41	102.62	101.60	102.71	0.002131	2.43	28.75	19.43	0.35
Reach-1	19.*	80.00	100.41	102.72	101.70	102.83	0.002438	2.60	30.78	20.91	0.38
Reach-1	19.*	90.00	100.41	102.82	101.79	102.93	0.002704	2.74	32.84	22.32	0.40
Reach-1	19.*	100.00	100.41	102.91	101.88	103.04	0.002921	2.86	34.92	23.56	0.41
Reach-1	19.*	200.00	100.41	103.63	102.63	103.84	0.003660	3.62	55.24	31.09	0.48
Reach-1	19.*	500.00	100.41	104.65	104.14	104.95	0.003528	4.79	179.60	224.72	0.51
Reach-1	19.*	750.00	100.41	105.07	104.76	105.38	0.003569	5.29	291.39	309.30	0.52
Reach-1	19.*	1000.00	100.41	105.36	105.08	105.69	0.003676	5.69	392.19	369.32	0.54
Reach-1	19.*	1500.00	100.41	105.78	105.58	106.11	0.003778	6.22	556.65	399.00	0.55
Reach-1	18.8	10.00	100.11	101.71	100.49	101.72	0.000142	0.56	17.78	14.06	0.09
Reach-1	18.8	20.00	100.11	101.95	100.68	101.96	0.000345	0.94	21.17	14.85	0.14
Reach-1	18.8	30.00	100.11	102.12	100.84	102.14	0.000569	1.26	23.77	15.67	0.18

Reach-1	18.8	40.00	100.11	102.26	100.97	102.30	0.000796	1.53	26.07	16.47	0.21
Reach-1	18.8	50.00	100.11	102.39	101.10	102.43	0.001019	1.78	28.15	17.16	0.24
Reach-1	18.8	60.00	100.11	102.50	101.21	102.56	0.001231	1.99	30.11	17.78	0.27
Reach-1	18.8	70.00	100.11	102.60	101.31	102.67	0.001436	2.19	31.94	18.35	0.29
Reach-1	18.8	80.00	100.11	102.69	101.41	102.78	0.001694	2.37	33.74	19.56	0.32
Reach-1	18.8	90.00	100.11	102.78	101.50	102.88	0.001946	2.53	35.56	20.78	0.34
Reach-1	18.8	100.00	100.11	102.87	101.59	102.98	0.002181	2.68	37.38	21.94	0.36
Reach-1	18.8	200.00	100.11	103.56	102.35	103.76	0.003632	3.58	55.81	31.34	0.47
Reach-1	18.8	500.00	100.11	104.59	104.05	104.87	0.003412	4.66	185.02	229.18	0.49
Reach-1	18.8	750.00	100.11	105.01	104.66	105.30	0.003451	5.15	298.28	313.38	0.51
Reach-1	18.8	1000.00	100.11	105.30	104.98	105.61	0.003545	5.54	400.82	373.58	0.52
Reach-1	18.8	1500.00	100.11	105.72	105.49	106.03	0.003644	6.06	565.50	399.00	0.54
Reach-1	18.6*	10.00	100.35	101.71	100.75	101.71	0.000241	0.66	15.19	14.53	0.11
Reach-1	18.6*	20.00	100.35	101.93	100.93	101.95	0.000549	1.07	18.61	15.72	0.17
Reach-1	18.6*	30.00	100.35	102.10	101.08	102.13	0.000867	1.41	21.27	16.80	0.22
Reach-1	18.6*	40.00	100.35	102.23	101.21	102.28	0.001168	1.69	23.62	17.70	0.26
Reach-1	18.6*	50.00	100.35	102.35	101.33	102.41	0.001498	1.94	25.73	18.91	0.29
Reach-1	18.6*	60.00	100.35	102.46	101.44	102.53	0.001852	2.16	27.82	20.54	0.33
Reach-1	18.6*	70.00	100.35	102.55	101.54	102.64	0.002178	2.34	29.87	22.01	0.35
Reach-1	18.6*	80.00	100.35	102.64	101.63	102.74	0.002453	2.51	31.92	23.26	0.38
Reach-1	18.6*	90.00	100.35	102.73	101.72	102.84	0.002693	2.65	33.96	24.43	0.40
Reach-1	18.6*	100.00	100.35	102.81	101.80	102.93	0.002903	2.78	35.99	25.55	0.41
Reach-1	18.6*	200.00	100.35	103.49	102.56	103.69	0.003502	3.59	55.73	30.87	0.47
Reach-1	18.6*	500.00	100.35	104.51	103.97	104.80	0.003344	4.72	185.10	229.72	0.50
Reach-1	18.6*	750.00	100.35	104.92	104.61	105.23	0.003464	5.26	295.62	312.20	0.52
Reach-1	18.6*	1000.00	100.35	105.21	104.89	105.53	0.003599	5.68	395.90	371.52	0.53
Reach-1	18.6*	1500.00	100.35	105.62	105.42	105.95	0.003761	6.25	557.20	399.00	0.56
Reach-1	18.4*	10.00	100.59	101.70	101.01	101.71	0.000507	0.81	12.29	15.26	0.16
Reach-1	18.4*	20.00	100.59	101.91	101.19	101.94	0.001032	1.27	15.77	17.10	0.23
Reach-1	18.4*	30.00	100.59	102.06	101.33	102.11	0.001579	1.62	18.50	19.06	0.29
Reach-1	18.4*	40.00	100.59	102.19	101.46	102.25	0.002111	1.90	21.05	21.27	0.34
Reach-1	18.4*	50.00	100.59	102.30	101.56	102.37	0.002533	2.13	23.44	22.81	0.37
Reach-1	18.4*	60.00	100.59	102.40	101.67	102.48	0.002879	2.33	25.76	24.19	0.40
Reach-1	18.4*	70.00	100.59	102.49	101.76	102.58	0.003180	2.50	27.99	25.44	0.42
Reach-1	18.4*	80.00	100.59	102.57	101.86	102.68	0.003422	2.65	30.21	26.63	0.44
Reach-1	18.4*	90.00	100.59	102.66	101.94	102.77	0.003594	2.77	32.44	27.66	0.45
Reach-1	18.4*	100.00	100.59	102.73	102.03	102.86	0.003703	2.88	34.67	28.50	0.46
Reach-1	18.4*	200.00	100.59	103.41	102.65	103.62	0.003627	3.69	54.26	29.93	0.48
Reach-1	18.4*	500.00	100.59	104.44	103.97	104.73	0.003391	4.80	185.44	231.37	0.50
Reach-1	18.4*	750.00	100.59	104.84	104.55	105.16	0.003505	5.34	296.20	313.58	0.52
Reach-1	18.4*	1000.00	100.59	105.13	104.86	105.46	0.003659	5.77	395.37	372.07	0.54
Reach-1	18.4*	1500.00	100.59	105.54	105.35	105.87	0.003820	6.34	555.87	399.00	0.56
Reach-1	18.2*	10.00	100.83	101.67	101.28	101.69	0.001545	1.09	9.15	17.14	0.26
Reach-1	18.2*	20.00	100.83	101.87	101.44	101.90	0.002590	1.55	12.92	21.09	0.35
Reach-1	18.2*	30.00	100.83	102.00	101.58	102.06	0.003256	1.88	15.95	23.05	0.40
Reach-1	18.2*	40.00	100.83	102.12	101.69	102.19	0.003758	2.14	18.68	24.69	0.43
Reach-1	18.2*	50.00	100.83	102.22	101.80	102.30	0.004126	2.36	21.18	25.94	0.46
Reach-1	18.2*	60.00	100.83	102.31	101.88	102.41	0.004350	2.54	23.62	26.94	0.48
Reach-1	18.2*	70.00	100.83	102.40	101.96	102.51	0.004404	2.70	25.94	27.19	0.49
Reach-1	18.2*	80.00	100.83	102.48	102.03	102.60	0.004415	2.84	28.17	27.35	0.49
Reach-1	18.2*	90.00	100.83	102.56	102.10	102.69	0.004408	2.97	30.35	27.50	0.50
Reach-1	18.2*	100.00	100.83	102.63	102.16	102.78	0.004389	3.08	32.47	27.64	0.50
Reach-1	18.2*	200.00	100.83	103.30	102.63	103.54	0.004149	3.90	51.33	28.91	0.52
Reach-1	18.2*	500.00	100.83	104.35	103.98	104.66	0.003620	4.95	183.26	231.88	0.52
Reach-1	18.2*	750.00	100.83	104.76	104.50	105.00	0.003669	5.45	295.09	314.83	0.53
Reach-1	18.2*	1000.00	100.83	105.05	104.78	105.38	0.003786	5.87	395.30	373.84	0.55

Reach-1	18.2*	1500.00	100.83	105.46	105.28	105.79	0.003862	6.38	558.49	399.00	0.57
Reach-1	18	10.00	101.07	101.55	101.49	101.61	0.015261	2.08	4.80	19.13	0.73
Reach-1	18	20.00	101.07	101.71	101.62	101.80	0.012533	2.40	8.32	23.08	0.71
Reach-1	18	30.00	101.07	101.83	101.72	101.94	0.011548	2.69	11.16	24.59	0.70
Reach-1	18	40.00	101.07	101.93	101.81	102.07	0.010740	2.91	13.76	25.48	0.70
Reach-1	18	50.00	101.07	102.02	101.88	102.18	0.010129	3.11	16.07	25.65	0.69
Reach-1	18	60.00	101.07	102.12	101.95	102.28	0.009391	3.26	18.42	25.82	0.68
Reach-1	18	70.00	101.07	102.20	102.01	102.38	0.008775	3.38	20.70	25.99	0.67
Reach-1	18	80.00	101.07	102.29	102.06	102.48	0.008252	3.49	22.92	26.15	0.66
Reach-1	18	90.00	101.07	102.37	102.12	102.57	0.007803	3.58	25.11	26.30	0.65
Reach-1	18	100.00	101.07	102.45	102.17	102.66	0.007421	3.67	27.24	26.46	0.64
Reach-1	18	200.00	101.07	103.14	102.64	103.44	0.005745	4.36	45.84	27.75	0.60
Reach-1	18	500.00	101.07	104.15	104.00	104.57	0.005198	5.67	152.22	206.31	0.61
Reach-1	18	750.00	101.07	104.58	104.47	104.99	0.004857	6.06	260.95	294.58	0.61
Reach-1	18	1000.00	101.07	104.93	104.75	105.30	0.004423	6.21	374.69	364.73	0.59
Reach-1	18	1500.00	101.07	105.37	105.21	105.71	0.004177	6.55	549.23	399.00	0.59
Reach-1	17.8*	10.00	100.77	101.24	101.18	101.32	0.014774	2.24	4.46	15.56	0.74
Reach-1	17.8*	20.00	100.77	101.40	101.33	101.52	0.015575	2.87	6.98	17.47	0.80
Reach-1	17.8*	30.00	100.77	101.55	101.45	101.69	0.013128	3.04	9.86	19.83	0.76
Reach-1	17.8*	40.00	100.77	101.70	101.55	101.84	0.011212	3.09	12.94	22.58	0.72
Reach-1	17.8*	50.00	100.77	101.83	101.64	101.98	0.009429	3.10	16.13	24.61	0.67
Reach-1	17.8*	60.00	100.77	101.95	101.73	102.10	0.008016	3.13	19.16	25.43	0.64
Reach-1	17.8*	70.00	100.77	102.06	101.80	102.22	0.007102	3.19	21.96	25.87	0.61
Reach-1	17.8*	80.00	100.77	102.16	101.86	102.33	0.006482	3.25	24.58	26.12	0.59
Reach-1	17.8*	90.00	100.77	102.26	101.92	102.43	0.006052	3.33	27.06	26.35	0.58
Reach-1	17.8*	100.00	100.77	102.35	101.98	102.52	0.005730	3.40	29.43	26.57	0.57
Reach-1	17.8*	200.00	100.77	103.06	102.45	103.32	0.004628	4.07	49.20	28.36	0.54
Reach-1	17.8*	500.00	100.77	104.08	103.81	104.46	0.004506	5.41	157.88	208.54	0.58
Reach-1	17.8*	750.00	100.77	104.49	104.35	104.89	0.004528	5.96	261.11	292.21	0.59
Reach-1	17.8*	1000.00	100.77	104.82	104.65	105.20	0.004335	6.23	367.66	358.66	0.59
Reach-1	17.8*	1500.00	100.77	105.27	105.12	105.62	0.004145	6.61	542.84	399.00	0.59
Reach-1	17.6*	10.00	100.48	100.95	100.88	101.03	0.013934	2.29	4.37	14.13	0.72
Reach-1	17.6*	20.00	100.48	101.19	101.03	101.29	0.008422	2.46	8.11	15.99	0.61
Reach-1	17.6*	30.00	100.48	101.38	101.16	101.49	0.007221	2.66	11.28	17.62	0.59
Reach-1	17.6*	40.00	100.48	101.54	101.27	101.67	0.006681	2.81	14.23	19.29	0.58
Reach-1	17.6*	50.00	100.48	101.69	101.37	101.82	0.006496	2.92	17.15	21.55	0.58
Reach-1	17.6*	60.00	100.48	101.82	101.46	101.96	0.006159	2.97	20.20	23.73	0.57
Reach-1	17.6*	70.00	100.48	101.95	101.55	102.09	0.005712	3.01	23.24	25.24	0.55
Reach-1	17.6*	80.00	100.48	102.06	101.63	102.20	0.005222	3.06	26.14	25.88	0.54
Reach-1	17.6*	90.00	100.48	102.16	101.71	102.31	0.004873	3.12	28.83	26.24	0.52
Reach-1	17.6*	100.00	100.48	102.26	101.78	102.42	0.004633	3.19	31.36	26.56	0.52
Reach-1	17.6*	200.00	100.48	103.00	102.29	103.23	0.003968	3.85	51.93	28.97	0.51
Reach-1	17.6*	500.00	100.48	104.01	103.64	104.37	0.004068	5.21	162.86	210.93	0.55
Reach-1	17.6*	750.00	100.48	104.42	104.23	104.80	0.004176	5.79	266.52	294.09	0.57
Reach-1	17.6*	1000.00	100.48	104.74	104.54	105.11	0.004083	6.11	371.93	359.45	0.57
Reach-1	17.6*	1500.00	100.48	105.17	105.03	105.54	0.004104	6.61	539.38	399.00	0.59
Reach-1	17.4*	10.00	100.18	100.90	100.57	100.92	0.002097	1.28	7.82	14.46	0.31
Reach-1	17.4*	20.00	100.18	101.14	100.73	101.19	0.002625	1.74	11.51	15.83	0.36
Reach-1	17.4*	30.00	100.18	101.33	100.86	101.39	0.002999	2.07	14.52	16.98	0.39
Reach-1	17.4*	40.00	100.18	101.48	100.98	101.56	0.003320	2.32	17.23	18.24	0.42
Reach-1	17.4*	50.00	100.18	101.62	101.08	101.72	0.003535	2.52	19.81	19.37	0.44
Reach-1	17.4*	60.00	100.18	101.74	101.18	101.86	0.003827	2.68	22.40	21.28	0.46
Reach-1	17.4*	70.00	100.18	101.86	101.27	101.99	0.003990	2.79	25.07	23.09	0.47
Reach-1	17.4*	80.00	100.18	101.98	101.35	102.11	0.004059	2.88	27.81	24.81	0.48
Reach-1	17.4*	90.00	100.18	102.09	101.44	102.22	0.003972	2.95	30.52	25.81	0.48

Reach-1	17.4*	100.00	100.18	102.19	101.51	102.33	0.003845	3.02	33.12	26.33	0.47
Reach-1	17.4*	200.00	100.18	102.94	102.14	103.15	0.003566	3.69	54.13	29.59	0.48
Reach-1	17.4*	500.00	100.18	103.94	103.46	104.28	0.003737	5.03	168.72	214.76	0.53
Reach-1	17.4*	750.00	100.18	104.35	104.12	104.71	0.003872	5.61	274.15	297.93	0.55
Reach-1	17.4*	1000.00	100.18	104.66	104.44	105.03	0.003921	6.00	375.33	360.12	0.56
Reach-1	17.4*	1500.00	100.18	105.09	104.95	105.45	0.004017	6.55	540.51	399.00	0.58
Reach-1	17.2*	10.00	99.88	100.89	100.26	100.90	0.000603	0.87	11.44	14.51	0.17
Reach-1	17.2*	20.00	99.88	101.12	100.44	101.15	0.001087	1.33	14.99	15.58	0.24
Reach-1	17.2*	30.00	99.88	101.30	100.57	101.34	0.001487	1.68	17.83	16.51	0.29
Reach-1	17.2*	40.00	99.88	101.45	100.70	101.51	0.001849	1.97	20.34	17.54	0.32
Reach-1	17.2*	50.00	99.88	101.58	100.81	101.65	0.002147	2.20	22.70	18.45	0.35
Reach-1	17.2*	60.00	99.88	101.70	100.91	101.79	0.002411	2.40	24.98	19.44	0.37
Reach-1	17.2*	70.00	99.88	101.81	101.00	101.91	0.002729	2.57	27.27	21.09	0.40
Reach-1	17.2*	80.00	99.88	101.92	101.09	102.03	0.002971	2.70	29.64	22.68	0.42
Reach-1	17.2*	90.00	99.88	102.02	101.17	102.15	0.003152	2.81	32.06	24.20	0.43
Reach-1	17.2*	100.00	99.88	102.12	101.25	102.25	0.003288	2.90	34.50	25.63	0.44
Reach-1	17.2*	200.00	99.88	102.87	101.96	103.08	0.003390	3.60	55.58	30.23	0.47
Reach-1	17.2*	500.00	99.88	103.88	103.31	104.20	0.003520	4.88	174.90	219.81	0.51
Reach-1	17.2*	750.00	99.88	104.30	104.02	104.63	0.003641	5.43	283.05	303.47	0.53
Reach-1	17.2*	1000.00	99.88	104.60	104.32	104.94	0.003762	5.86	382.48	363.79	0.55
Reach-1	17.2*	1500.00	99.88	105.02	104.85	105.37	0.003873	6.40	547.49	399.00	0.57
Reach-1	17.*	10.00	99.59	100.88	99.97	100.89	0.000264	0.68	14.71	14.34	0.12
Reach-1	17.*	20.00	99.59	101.11	100.15	101.13	0.000575	1.10	18.13	15.23	0.18
Reach-1	17.*	30.00	99.59	101.29	100.29	101.32	0.000879	1.44	20.82	16.05	0.22
Reach-1	17.*	40.00	99.59	101.43	100.42	101.47	0.001178	1.73	23.16	16.93	0.26
Reach-1	17.*	50.00	99.59	101.55	100.54	101.62	0.001449	1.97	25.35	17.71	0.29
Reach-1	17.*	60.00	99.59	101.67	100.64	101.74	0.001690	2.19	27.45	18.43	0.32
Reach-1	17.*	70.00	99.59	101.78	100.74	101.86	0.001953	2.38	29.46	19.45	0.34
Reach-1	17.*	80.00	99.59	101.88	100.84	101.98	0.002232	2.54	31.51	20.86	0.36
Reach-1	17.*	90.00	99.59	101.98	100.93	102.09	0.002473	2.68	33.60	22.21	0.38
Reach-1	17.*	100.00	99.59	102.07	101.01	102.19	0.002679	2.80	35.72	23.50	0.40
Reach-1	17.*	200.00	99.59	102.81	101.73	103.01	0.003420	3.57	56.10	30.81	0.47
Reach-1	17.*	500.00	99.59	103.83	103.24	104.12	0.003426	4.76	180.04	224.28	0.50
Reach-1	17.*	750.00	99.59	104.23	103.92	104.55	0.003552	5.31	288.91	307.07	0.52
Reach-1	17.*	1000.00	99.59	104.53	104.25	104.86	0.003654	5.71	390.07	367.65	0.54
Reach-1	17.*	1500.00	99.59	104.95	104.76	105.29	0.003764	6.25	554.98	399.00	0.56
Reach-1	16.8	10.00	99.29	100.88	99.67	100.89	0.000146	0.57	17.60	14.02	0.09
Reach-1	16.8	20.00	99.29	101.11	99.86	101.12	0.000359	0.96	20.88	14.78	0.14
Reach-1	16.8	30.00	99.29	101.28	100.02	101.30	0.000591	1.28	23.42	15.54	0.18
Reach-1	16.8	40.00	99.29	101.41	100.15	101.45	0.000832	1.56	25.63	16.31	0.22
Reach-1	16.8	50.00	99.29	101.54	100.28	101.59	0.001066	1.81	27.66	17.00	0.25
Reach-1	16.8	60.00	99.29	101.65	100.39	101.71	0.001287	2.03	29.60	17.62	0.28
Reach-1	16.8	70.00	99.29	101.75	100.49	101.83	0.001498	2.23	31.43	18.19	0.30
Reach-1	16.8	80.00	99.29	101.85	100.59	101.94	0.001743	2.41	33.21	19.18	0.32
Reach-1	16.8	90.00	99.29	101.94	100.68	102.04	0.002003	2.57	35.02	20.43	0.35
Reach-1	16.8	100.00	99.29	102.03	100.77	102.14	0.002242	2.71	36.85	21.61	0.37
Reach-1	16.8	200.00	99.29	102.73	101.53	102.94	0.003667	3.60	55.58	31.24	0.48
Reach-1	16.8	500.00	99.29	103.76	103.23	104.05	0.003448	4.68	183.81	228.10	0.50
Reach-1	16.8	750.00	99.29	104.17	103.84	104.47	0.003539	5.20	294.06	310.64	0.51
Reach-1	16.8	1000.00	99.29	104.48	104.16	104.79	0.003595	5.57	397.90	371.99	0.53
Reach-1	16.8	1500.00	99.29	104.90	104.68	105.21	0.003673	6.08	563.78	399.00	0.54
Reach-1	16.6*	10.00	99.53	100.88	99.91	100.88	0.000213	0.62	16.05	15.26	0.11
Reach-1	16.6*	20.00	99.53	101.10	100.09	101.11	0.000487	1.02	19.54	16.35	0.16
Reach-1	16.6*	30.00	99.53	101.26	100.23	101.29	0.000770	1.35	22.29	17.41	0.21
Reach-1	16.6*	40.00	99.53	101.39	100.35	101.43	0.001045	1.62	24.66	18.28	0.25

Reach-1	16.6*	50.00	99.53	101.51	100.47	101.56	0.001307	1.86	26.84	19.12	0.28
Reach-1	16.6*	60.00	99.53	101.62	100.57	101.68	0.001612	2.07	28.97	20.64	0.31
Reach-1	16.6*	70.00	99.53	101.72	100.66	101.79	0.001893	2.25	31.07	22.02	0.33
Reach-1	16.6*	80.00	99.53	101.81	100.76	101.90	0.002145	2.41	33.17	23.33	0.36
Reach-1	16.6*	90.00	99.53	101.90	100.84	102.00	0.002367	2.55	35.27	24.57	0.38
Reach-1	16.6*	100.00	99.53	101.98	100.92	102.09	0.002561	2.67	37.38	25.76	0.39
Reach-1	16.6*	200.00	99.53	102.67	101.65	102.86	0.003213	3.51	56.97	30.73	0.45
Reach-1	16.6*	500.00	99.53	103.70	103.06	103.98	0.003178	4.66	187.55	231.18	0.49
Reach-1	16.6*	750.00	99.53	104.09	103.77	104.40	0.003421	5.27	293.83	310.72	0.51
Reach-1	16.6*	1000.00	99.53	104.39	104.10	104.71	0.003550	5.69	394.87	370.84	0.53
Reach-1	16.6*	1500.00	99.53	104.80	104.60	105.13	0.003726	6.27	556.21	399.00	0.56
Reach-1	16.4*	10.00	99.77	100.87	100.16	100.88	0.000392	0.73	13.70	16.58	0.14
Reach-1	16.4*	20.00	99.77	101.08	100.32	101.10	0.000806	1.15	17.41	18.33	0.21
Reach-1	16.4*	30.00	99.77	101.23	100.45	101.27	0.001196	1.47	20.35	19.77	0.26
Reach-1	16.4*	40.00	99.77	101.36	100.57	101.41	0.001609	1.74	22.94	21.67	0.30
Reach-1	16.4*	50.00	99.77	101.47	100.67	101.53	0.001965	1.96	25.45	23.34	0.33
Reach-1	16.4*	60.00	99.77	101.57	100.77	101.65	0.002265	2.15	27.91	24.88	0.36
Reach-1	16.4*	70.00	99.77	101.67	100.86	101.75	0.002454	2.31	30.31	25.76	0.38
Reach-1	16.4*	80.00	99.77	101.76	100.94	101.85	0.002570	2.45	32.64	26.25	0.39
Reach-1	16.4*	90.00	99.77	101.84	101.03	101.95	0.002659	2.58	34.90	26.62	0.40
Reach-1	16.4*	100.00	99.77	101.92	101.10	102.04	0.002737	2.70	37.08	26.98	0.41
Reach-1	16.4*	200.00	99.77	102.60	101.72	102.80	0.003163	3.55	56.39	29.93	0.46
Reach-1	16.4*	500.00	99.77	103.63	103.05	103.91	0.003083	4.68	191.78	235.80	0.48
Reach-1	16.4*	750.00	99.77	104.02	103.71	104.33	0.003380	5.32	296.79	313.34	0.52
Reach-1	16.4*	1000.00	99.77	104.31	104.02	104.64	0.003550	5.77	396.07	372.08	0.54
Reach-1	16.4*	1500.00	99.77	104.71	104.53	105.05	0.003773	6.38	554.39	399.00	0.56
Reach-1	16.2*	10.00	100.01	100.85	100.41	100.86	0.001061	0.95	10.57	18.53	0.22
Reach-1	16.2*	20.00	100.01	101.05	100.56	101.08	0.001806	1.38	14.51	21.57	0.30
Reach-1	16.2*	30.00	100.01	101.19	100.69	101.23	0.002385	1.69	17.78	24.04	0.35
Reach-1	16.2*	40.00	100.01	101.31	100.80	101.37	0.002740	1.94	20.66	25.18	0.38
Reach-1	16.2*	50.00	100.01	101.41	100.89	101.48	0.002958	2.14	23.32	25.81	0.40
Reach-1	16.2*	60.00	100.01	101.51	100.98	101.59	0.003088	2.32	25.83	26.09	0.41
Reach-1	16.2*	70.00	100.01	101.60	101.06	101.69	0.003191	2.48	28.19	26.34	0.42
Reach-1	16.2*	80.00	100.01	101.69	101.14	101.79	0.003258	2.62	30.50	26.59	0.43
Reach-1	16.2*	90.00	100.01	101.77	101.21	101.89	0.003312	2.75	32.72	26.83	0.44
Reach-1	16.2*	100.00	100.01	101.85	101.27	101.98	0.003356	2.87	34.86	27.06	0.45
Reach-1	16.2*	200.00	100.01	102.51	101.74	102.73	0.003610	3.74	53.46	28.95	0.49
Reach-1	16.2*	500.00	100.01	103.55	103.11	103.85	0.003306	4.82	189.94	236.60	0.50
Reach-1	16.2*	750.00	100.01	103.94	103.66	104.26	0.003548	5.43	296.22	314.77	0.53
Reach-1	16.2*	1000.00	100.01	104.23	103.98	104.56	0.003697	5.86	395.68	373.38	0.55
Reach-1	16.2*	1500.00	100.01	104.63	104.46	104.97	0.003864	6.44	555.10	399.00	0.57
Reach-1	16	10.00	100.25	100.76	100.67	100.81	0.011103	1.86	5.36	19.92	0.63
Reach-1	16	20.00	100.25	100.93	100.80	101.00	0.009284	2.18	9.19	23.63	0.61
Reach-1	16	30.00	100.25	101.05	100.90	101.15	0.008700	2.45	12.25	25.05	0.62
Reach-1	16	40.00	100.25	101.16	100.99	101.27	0.008218	2.68	14.94	25.56	0.62
Reach-1	16	50.00	100.25	101.26	101.06	101.39	0.007688	2.86	17.50	25.75	0.61
Reach-1	16	60.00	100.25	101.35	101.13	101.50	0.007269	3.01	19.94	25.93	0.60
Reach-1	16	70.00	100.25	101.44	101.19	101.60	0.006957	3.15	22.24	26.10	0.60
Reach-1	16	80.00	100.25	101.53	101.24	101.70	0.006638	3.26	24.53	26.26	0.59
Reach-1	16	90.00	100.25	101.61	101.30	101.79	0.006385	3.37	26.73	26.42	0.59
Reach-1	16	100.00	100.25	101.69	101.35	101.88	0.006188	3.47	28.84	26.57	0.59
Reach-1	16	200.00	100.25	102.35	101.81	102.64	0.005416	4.28	46.71	27.81	0.58
Reach-1	16	500.00	100.25	103.34	103.18	103.75	0.005078	5.62	154.60	208.64	0.61
Reach-1	16	750.00	100.25	103.78	103.65	104.17	0.004718	5.99	265.28	297.55	0.60
Reach-1	16	1000.00	100.25	104.11	103.93	104.48	0.004376	6.18	376.77	365.89	0.59
Reach-1	16	1500.00	100.25	104.55	104.39	104.89	0.004222	6.57	546.98	399.00	0.59

Reach-1	15.8*	10.00	99.95	100.46	100.40	100.55	0.015758	2.38	4.20	14.00	0.77
Reach-1	15.8*	20.00	99.95	100.63	100.56	100.76	0.015667	2.89	6.93	17.24	0.80
Reach-1	15.8*	30.00	99.95	100.80	100.70	100.93	0.012925	2.96	10.13	20.93	0.75
Reach-1	15.8*	40.00	99.95	100.95	100.79	101.09	0.010363	2.99	13.37	23.04	0.69
Reach-1	15.8*	50.00	99.95	101.08	100.88	101.22	0.008782	3.01	16.60	24.96	0.65
Reach-1	15.8*	60.00	99.95	101.20	100.96	101.35	0.007711	3.05	19.67	26.30	0.62
Reach-1	15.8*	70.00	99.95	101.31	101.03	101.46	0.006840	3.11	22.53	26.69	0.60
Reach-1	15.8*	80.00	99.95	101.41	101.09	101.56	0.006219	3.17	25.22	26.87	0.58
Reach-1	15.8*	90.00	99.95	101.50	101.16	101.66	0.005819	3.25	27.71	27.05	0.57
Reach-1	15.8*	100.00	99.95	101.59	101.21	101.76	0.005548	3.33	30.05	27.21	0.56
Reach-1	15.8*	200.00	99.95	102.27	101.66	102.53	0.004731	4.08	49.05	28.48	0.55
Reach-1	15.8*	500.00	99.95	103.26	103.02	103.65	0.004607	5.43	158.39	209.85	0.58
Reach-1	15.8*	750.00	99.95	103.68	103.53	104.07	0.004503	5.91	265.04	295.51	0.59
Reach-1	15.8*	1000.00	99.95	104.01	103.83	104.39	0.004293	6.17	372.75	362.00	0.58
Reach-1	15.8*	1500.00	99.95	104.44	104.30	104.80	0.004232	6.62	540.76	399.00	0.59
Reach-1	15.6*	10.00	99.65	100.15	100.09	100.24	0.014818	2.45	4.08	12.42	0.75
Reach-1	15.6*	20.00	99.65	100.40	100.26	100.52	0.009571	2.66	7.51	14.47	0.65
Reach-1	15.6*	30.00	99.65	100.60	100.39	100.73	0.008376	2.85	10.52	16.49	0.63
Reach-1	15.6*	40.00	99.65	100.77	100.51	100.90	0.007918	2.97	13.46	19.00	0.62
Reach-1	15.6*	50.00	99.65	100.92	100.62	101.06	0.007442	3.02	16.54	21.70	0.61
Reach-1	15.6*	60.00	99.65	101.06	100.72	101.20	0.006765	3.05	19.67	23.67	0.59
Reach-1	15.6*	70.00	99.65	101.18	100.82	101.33	0.006320	3.09	22.66	25.42	0.58
Reach-1	15.6*	80.00	99.65	101.29	100.90	101.44	0.005908	3.12	25.61	26.83	0.56
Reach-1	15.6*	90.00	99.65	101.39	100.97	101.55	0.005500	3.17	28.43	27.61	0.55
Reach-1	15.6*	100.00	99.65	101.49	101.04	101.65	0.005122	3.22	31.05	27.79	0.54
Reach-1	15.6*	200.00	99.65	102.20	101.54	102.43	0.004233	3.91	51.19	29.15	0.52
Reach-1	15.6*	500.00	99.65	103.19	102.87	103.56	0.004205	5.24	163.58	213.07	0.56
Reach-1	15.6*	750.00	99.65	103.61	103.43	103.98	0.004211	5.76	270.05	297.75	0.57
Reach-1	15.6*	1000.00	99.65	103.92	103.73	104.29	0.004164	6.10	373.12	361.29	0.58
Reach-1	15.6*	1500.00	99.65	104.35	104.21	104.71	0.004154	6.58	540.50	399.00	0.59
Reach-1	15.4*	10.00	99.35	100.09	99.77	100.12	0.002546	1.41	7.09	13.06	0.34
Reach-1	15.4*	20.00	99.35	100.34	99.95	100.40	0.003162	1.90	10.53	14.51	0.39
Reach-1	15.4*	30.00	99.35	100.53	100.09	100.61	0.003642	2.25	13.35	15.83	0.43
Reach-1	15.4*	40.00	99.35	100.69	100.22	100.78	0.003981	2.51	15.96	17.15	0.46
Reach-1	15.4*	50.00	99.35	100.83	100.33	100.94	0.004388	2.71	18.46	18.96	0.48
Reach-1	15.4*	60.00	99.35	100.96	100.43	101.08	0.004731	2.84	21.11	21.37	0.50
Reach-1	15.4*	70.00	99.35	101.08	100.53	101.21	0.004785	2.94	23.80	23.07	0.51
Reach-1	15.4*	80.00	99.35	101.19	100.62	101.33	0.004769	3.02	26.51	24.65	0.51
Reach-1	15.4*	90.00	99.35	101.30	100.71	101.44	0.004731	3.08	29.19	26.12	0.51
Reach-1	15.4*	100.00	99.35	101.40	100.79	101.55	0.004658	3.14	31.84	27.37	0.51
Reach-1	15.4*	200.00	99.35	102.13	101.42	102.35	0.003903	3.77	52.98	29.82	0.50
Reach-1	15.4*	500.00	99.35	103.12	102.73	103.46	0.003948	5.09	167.46	215.17	0.54
Reach-1	15.4*	750.00	99.35	103.55	103.32	103.90	0.003943	5.59	276.70	301.00	0.55
Reach-1	15.4*	1000.00	99.35	103.84	103.63	104.21	0.004041	6.01	374.98	361.19	0.57
Reach-1	15.4*	1500.00	99.35	104.27	104.12	104.63	0.004111	6.54	539.67	399.00	0.58
Reach-1	15.2*	10.00	99.06	100.08	99.46	100.09	0.000701	0.94	10.67	13.58	0.19
Reach-1	15.2*	20.00	99.06	100.32	99.64	100.35	0.001245	1.42	14.08	14.66	0.26
Reach-1	15.2*	30.00	99.06	100.50	99.79	100.55	0.001721	1.79	16.78	15.72	0.30
Reach-1	15.2*	40.00	99.06	100.65	99.92	100.72	0.002124	2.08	19.25	16.81	0.34
Reach-1	15.2*	50.00	99.06	100.78	100.03	100.87	0.002466	2.32	21.52	17.75	0.37
Reach-1	15.2*	60.00	99.06	100.90	100.14	101.00	0.002858	2.53	23.76	19.33	0.40
Reach-1	15.2*	70.00	99.06	101.02	100.24	101.13	0.003213	2.69	26.04	21.08	0.43
Reach-1	15.2*	80.00	99.06	101.12	100.33	101.25	0.003460	2.82	28.40	22.67	0.44
Reach-1	15.2*	90.00	99.06	101.23	100.42	101.36	0.003633	2.93	30.76	24.09	0.46
Reach-1	15.2*	100.00	99.06	101.32	100.51	101.46	0.003763	3.02	33.13	25.42	0.47

Reach-1	15.2*	200.00	99.06	102.06	101.23	102.27	0.003702	3.67	54.45	30.51	0.48
Reach-1	15.2*	500.00	99.06	103.07	102.59	103.38	0.003648	4.90	175.60	221.55	0.52
Reach-1	15.2*	750.00	99.06	103.49	103.21	103.81	0.003681	5.40	286.38	306.29	0.53
Reach-1	15.2*	1000.00	99.06	103.78	103.52	104.12	0.003795	5.82	385.84	366.02	0.55
Reach-1	15.2*	1500.00	99.06	104.20	104.02	104.54	0.003894	6.36	550.18	399.00	0.57
Reach-1	15.*	10.00	98.76	100.07	99.15	100.08	0.000279	0.70	14.31	13.89	0.12
Reach-1	15.*	20.00	98.76	100.31	99.34	100.33	0.000603	1.13	17.70	14.79	0.18
Reach-1	15.*	30.00	98.76	100.49	99.49	100.52	0.000930	1.47	20.35	15.70	0.23
Reach-1	15.*	40.00	98.76	100.63	99.62	100.68	0.001237	1.76	22.72	16.62	0.27
Reach-1	15.*	50.00	98.76	100.76	99.74	100.82	0.001523	2.01	24.87	17.42	0.30
Reach-1	15.*	60.00	98.76	100.87	99.85	100.95	0.001780	2.23	26.93	18.14	0.32
Reach-1	15.*	70.00	98.76	100.98	99.95	101.07	0.002108	2.42	28.91	19.55	0.35
Reach-1	15.*	80.00	98.76	101.08	100.05	101.18	0.002410	2.58	30.96	21.04	0.38
Reach-1	15.*	90.00	98.76	101.18	100.14	101.29	0.002672	2.73	33.03	22.43	0.40
Reach-1	15.*	100.00	98.76	101.27	100.23	101.39	0.002886	2.85	35.11	23.67	0.41
Reach-1	15.*	200.00	98.76	101.99	100.98	102.19	0.003604	3.60	55.53	31.13	0.48
Reach-1	15.*	500.00	98.76	103.01	102.49	103.30	0.003465	4.75	181.71	226.60	0.50
Reach-1	15.*	750.00	98.76	103.42	103.11	103.73	0.003518	5.26	293.78	310.86	0.52
Reach-1	15.*	1000.00	98.76	103.72	103.43	104.04	0.003627	5.66	394.92	370.82	0.53
Reach-1	15.*	1500.00	98.76	104.14	103.93	104.46	0.003727	6.19	559.63	399.00	0.55
Reach-1	14.8	10.00	98.46	100.07	98.84	100.08	0.000139	0.56	17.92	14.09	0.09
Reach-1	14.8	20.00	98.46	100.31	99.03	100.32	0.000339	0.94	21.31	14.88	0.14
Reach-1	14.8	30.00	98.46	100.48	99.19	100.50	0.000560	1.25	23.91	15.72	0.18
Reach-1	14.8	40.00	98.46	100.62	99.32	100.66	0.000784	1.53	26.22	16.52	0.21
Reach-1	14.8	50.00	98.46	100.74	99.45	100.79	0.001004	1.77	28.30	17.21	0.24
Reach-1	14.8	60.00	98.46	100.86	99.56	100.92	0.001214	1.98	30.27	17.83	0.27
Reach-1	14.8	70.00	98.46	100.96	99.66	101.03	0.001418	2.18	32.10	18.40	0.29
Reach-1	14.8	80.00	98.46	101.05	99.76	101.14	0.001679	2.36	33.91	19.67	0.32
Reach-1	14.8	90.00	98.46	101.14	99.85	101.24	0.001928	2.52	35.74	20.89	0.34
Reach-1	14.8	100.00	98.46	101.23	99.94	101.34	0.002159	2.66	37.57	22.05	0.36
Reach-1	14.8	200.00	98.46	101.92	100.70	102.12	0.003582	3.56	56.14	31.48	0.47
Reach-1	14.8	500.00	98.46	102.95	102.40	103.22	0.003338	4.63	187.65	231.48	0.49
Reach-1	14.8	750.00	98.46	103.36	103.01	103.65	0.003390	5.12	301.27	315.30	0.50
Reach-1	14.8	1000.00	98.46	103.66	103.33	103.96	0.003490	5.51	404.10	375.35	0.52
Reach-1	14.8	1500.00	98.46	104.08	103.84	104.38	0.003587	6.02	569.01	399.00	0.54
Reach-1	14.6*	10.00	98.70	100.07	99.10	100.07	0.000237	0.65	15.28	14.54	0.11
Reach-1	14.6*	20.00	98.70	100.29	99.29	100.31	0.000543	1.07	18.69	15.74	0.17
Reach-1	14.6*	30.00	98.70	100.46	99.43	100.49	0.000860	1.41	21.34	16.84	0.22
Reach-1	14.6*	40.00	98.70	100.59	99.57	100.64	0.001160	1.69	23.70	17.75	0.26
Reach-1	14.6*	50.00	98.70	100.71	99.68	100.77	0.001492	1.94	25.82	19.01	0.29
Reach-1	14.6*	60.00	98.70	100.82	99.79	100.89	0.001837	2.15	27.92	20.58	0.33
Reach-1	14.6*	70.00	98.70	100.91	99.89	101.00	0.002156	2.34	29.96	22.00	0.35
Reach-1	14.6*	80.00	98.70	101.00	99.98	101.10	0.002432	2.50	32.00	23.28	0.38
Reach-1	14.6*	90.00	98.70	101.09	100.07	101.20	0.002676	2.64	34.04	24.47	0.39
Reach-1	14.6*	100.00	98.70	101.17	100.16	101.29	0.002889	2.77	36.08	25.61	0.41
Reach-1	14.6*	200.00	98.70	101.85	100.92	102.05	0.003468	3.58	55.92	30.90	0.47
Reach-1	14.6*	500.00	98.70	102.88	102.33	103.16	0.003274	4.68	187.99	232.36	0.49
Reach-1	14.6*	750.00	98.70	103.28	102.95	103.58	0.003386	5.21	299.83	315.00	0.51
Reach-1	14.6*	1000.00	98.70	103.58	103.27	103.89	0.003522	5.63	400.81	374.25	0.53
Reach-1	14.6*	1500.00	98.70	103.99	103.78	104.31	0.003665	6.18	563.12	399.00	0.55
Reach-1	14.4*	10.00	98.94	100.06	99.36	100.07	0.000493	0.81	12.41	15.33	0.16
Reach-1	14.4*	20.00	98.94	100.27	99.54	100.30	0.001007	1.26	15.90	17.12	0.23
Reach-1	14.4*	30.00	98.94	100.42	99.68	100.46	0.001551	1.61	18.62	19.12	0.29
Reach-1	14.4*	40.00	98.94	100.55	99.81	100.61	0.002087	1.89	21.19	21.43	0.33
Reach-1	14.4*	50.00	98.94	100.66	99.92	100.73	0.002497	2.12	23.59	22.94	0.37

Reach-1	14.4*	60.00	98.94	100.76	100.02	100.84	0.002837	2.31	25.93	24.32	0.39
Reach-1	14.4*	70.00	98.94	100.85	100.12	100.94	0.003134	2.49	28.17	25.57	0.42
Reach-1	14.4*	80.00	98.94	100.93	100.21	101.04	0.003369	2.63	30.41	26.76	0.43
Reach-1	14.4*	90.00	98.94	101.02	100.30	101.13	0.003530	2.76	32.65	27.72	0.45
Reach-1	14.4*	100.00	98.94	101.09	100.38	101.22	0.003631	2.87	34.88	28.50	0.46
Reach-1	14.4*	200.00	98.94	101.77	101.01	101.98	0.003571	3.67	54.53	29.95	0.48
Reach-1	14.4*	500.00	98.94	102.80	102.31	103.09	0.003296	4.75	188.92	234.14	0.50
Reach-1	14.4*	750.00	98.94	103.21	102.90	103.51	0.003396	5.27	301.46	316.57	0.51
Reach-1	14.4*	1000.00	98.94	103.50	103.21	103.82	0.003552	5.71	401.39	374.86	0.53
Reach-1	14.4*	1500.00	98.94	103.91	103.70	104.23	0.003718	6.28	561.74	399.00	0.56
Reach-1	14.2*	10.00	99.19	100.03	99.63	100.05	0.001516	1.09	9.21	17.16	0.26
Reach-1	14.2*	20.00	99.19	100.23	99.80	100.26	0.002556	1.54	12.98	21.10	0.35
Reach-1	14.2*	30.00	99.19	100.36	99.94	100.42	0.003228	1.88	16.00	23.06	0.40
Reach-1	14.2*	40.00	99.19	100.48	100.05	100.55	0.003730	2.14	18.72	24.69	0.43
Reach-1	14.2*	50.00	99.19	100.58	100.16	100.66	0.004106	2.36	21.23	25.98	0.46
Reach-1	14.2*	60.00	99.19	100.67	100.24	100.77	0.004338	2.53	23.68	27.04	0.48
Reach-1	14.2*	70.00	99.19	100.76	100.32	100.87	0.004377	2.69	25.99	27.20	0.49
Reach-1	14.2*	80.00	99.19	100.84	100.39	100.96	0.004388	2.83	28.23	27.36	0.49
Reach-1	14.2*	90.00	99.19	100.92	100.46	101.05	0.004383	2.96	30.41	27.51	0.50
Reach-1	14.2*	100.00	99.19	100.99	100.52	101.14	0.004365	3.07	32.53	27.65	0.50
Reach-1	14.2*	200.00	99.19	101.66	100.98	101.90	0.004122	3.89	51.44	28.91	0.51
Reach-1	14.2*	500.00	99.19	102.71	102.34	103.02	0.003614	4.95	183.31	231.87	0.52
Reach-1	14.2*	750.00	99.19	103.12	102.86	103.44	0.003662	5.45	295.26	314.90	0.53
Reach-1	14.2*	1000.00	99.19	103.41	103.15	103.74	0.003788	5.87	395.07	373.68	0.55
Reach-1	14.2*	1500.00	99.19	103.82	103.64	104.15	0.003873	6.39	557.76	399.00	0.57
Reach-1	14	10.00	99.43	99.92	99.85	99.98	0.013424	1.99	5.02	19.44	0.69
Reach-1	14	20.00	99.43	100.08	99.98	100.16	0.011987	2.37	8.44	23.16	0.69
Reach-1	14	30.00	99.43	100.19	100.08	100.30	0.011446	2.68	11.19	24.60	0.70
Reach-1	14	40.00	99.43	100.29	100.17	100.43	0.010717	2.90	13.77	25.48	0.70
Reach-1	14	50.00	99.43	100.38	100.24	100.53	0.010172	3.11	16.05	25.65	0.69
Reach-1	14	60.00	99.43	100.48	100.31	100.64	0.009420	3.26	18.40	25.82	0.68
Reach-1	14	70.00	99.43	100.56	100.37	100.74	0.008795	3.38	20.68	25.98	0.67
Reach-1	14	80.00	99.43	100.65	100.42	100.84	0.008261	3.49	22.91	26.15	0.66
Reach-1	14	90.00	99.43	100.73	100.48	100.93	0.007817	3.59	25.09	26.30	0.65
Reach-1	14	100.00	99.43	100.81	100.53	101.02	0.007432	3.67	27.23	26.46	0.64
Reach-1	14	200.00	99.43	101.50	101.00	101.80	0.005727	4.36	45.88	27.76	0.60
Reach-1	14	500.00	99.43	102.50	102.36	102.93	0.005234	5.68	151.52	205.62	0.62
Reach-1	14	750.00	99.43	102.94	102.83	103.35	0.004856	6.06	261.00	294.61	0.61
Reach-1	14	1000.00	99.43	103.28	103.11	103.65	0.004447	6.22	373.63	364.14	0.59
Reach-1	14	1500.00	99.43	103.73	103.57	104.07	0.004211	6.57	547.52	399.00	0.59
Reach-1	13.8*	10.00	99.13	99.59	99.54	99.67	0.017287	2.36	4.24	15.39	0.79
Reach-1	13.8*	20.00	99.13	99.75	99.69	99.88	0.016503	2.92	6.84	17.36	0.82
Reach-1	13.8*	30.00	99.13	99.91	99.81	100.05	0.013489	3.07	9.76	19.76	0.77
Reach-1	13.8*	40.00	99.13	100.05	99.92	100.20	0.011411	3.11	12.88	22.61	0.73
Reach-1	13.8*	50.00	99.13	100.19	100.01	100.34	0.009483	3.10	16.11	24.61	0.68
Reach-1	13.8*	60.00	99.13	100.31	100.09	100.46	0.008013	3.13	19.16	25.44	0.64
Reach-1	13.8*	70.00	99.13	100.42	100.16	100.58	0.007088	3.18	21.98	25.88	0.61
Reach-1	13.8*	80.00	99.13	100.52	100.22	100.69	0.006458	3.25	24.61	26.13	0.59
Reach-1	13.8*	90.00	99.13	100.62	100.28	100.79	0.006040	3.32	27.08	26.36	0.58
Reach-1	13.8*	100.00	99.13	100.71	100.34	100.88	0.005718	3.40	29.45	26.59	0.57
Reach-1	13.8*	200.00	99.13	101.43	100.81	101.68	0.004600	4.06	49.30	28.37	0.54
Reach-1	13.8*	500.00	99.13	102.43	102.18	102.82	0.004535	5.42	157.13	207.77	0.58
Reach-1	13.8*	750.00	99.13	102.85	102.71	103.25	0.004516	5.95	261.45	292.43	0.59
Reach-1	13.8*	1000.00	99.13	103.17	103.01	103.56	0.004404	6.27	364.53	356.87	0.59
Reach-1	13.8*	1500.00	99.13	103.61	103.48	103.98	0.004227	6.66	538.64	399.00	0.59

Reach-1	13.6*	10.00	98.83	99.31	99.23	99.39	0.011989	2.18	4.59	14.21	0.68
Reach-1	13.6*	20.00	98.83	99.56	99.38	99.65	0.007711	2.40	8.35	16.08	0.59
Reach-1	13.6*	30.00	98.83	99.75	99.51	99.85	0.006751	2.60	11.54	17.73	0.57
Reach-1	13.6*	40.00	98.83	99.91	99.62	100.03	0.006321	2.76	14.48	19.34	0.56
Reach-1	13.6*	50.00	98.83	100.05	99.72	100.18	0.006204	2.87	17.41	21.63	0.56
Reach-1	13.6*	60.00	98.83	100.19	99.81	100.32	0.005914	2.93	20.48	23.82	0.56
Reach-1	13.6*	70.00	98.83	100.31	99.90	100.45	0.005505	2.98	23.52	25.29	0.54
Reach-1	13.6*	80.00	98.83	100.42	99.98	100.57	0.005053	3.03	26.41	25.93	0.53
Reach-1	13.6*	90.00	98.83	100.53	100.06	100.67	0.004741	3.10	29.08	26.26	0.52
Reach-1	13.6*	100.00	98.83	100.62	100.13	100.78	0.004520	3.16	31.60	26.57	0.51
Reach-1	13.6*	200.00	98.83	101.36	100.64	101.59	0.003897	3.83	52.22	28.98	0.50
Reach-1	13.6*	500.00	98.83	102.36	101.99	102.72	0.004065	5.21	162.61	210.80	0.55
Reach-1	13.6*	750.00	98.83	102.78	102.58	103.16	0.004107	5.76	268.90	296.01	0.57
Reach-1	13.6*	1000.00	98.83	103.09	102.90	103.47	0.004126	6.13	369.73	358.59	0.58
Reach-1	13.6*	1500.00	98.83	103.52	103.38	103.89	0.004164	6.65	536.12	399.00	0.59
Reach-1	13.4*	10.00	98.54	99.27	98.93	99.29	0.001963	1.25	7.99	14.53	0.30
Reach-1	13.4*	20.00	98.54	99.51	99.09	99.56	0.002509	1.71	11.69	15.90	0.35
Reach-1	13.4*	30.00	98.54	99.69	99.22	99.76	0.002896	2.04	14.71	17.09	0.39
Reach-1	13.4*	40.00	98.54	99.85	99.34	99.93	0.003218	2.30	17.43	18.32	0.41
Reach-1	13.4*	50.00	98.54	99.98	99.44	100.08	0.003439	2.50	20.01	19.45	0.43
Reach-1	13.4*	60.00	98.54	100.11	99.54	100.22	0.003741	2.65	22.62	21.43	0.46
Reach-1	13.4*	70.00	98.54	100.23	99.62	100.35	0.003914	2.77	25.30	23.28	0.47
Reach-1	13.4*	80.00	98.54	100.34	99.71	100.47	0.003991	2.85	28.05	25.04	0.47
Reach-1	13.4*	90.00	98.54	100.45	99.79	100.58	0.003893	2.93	30.75	25.89	0.47
Reach-1	13.4*	100.00	98.54	100.55	99.87	100.69	0.003774	3.00	33.33	26.39	0.47
Reach-1	13.4*	200.00	98.54	101.30	100.49	101.51	0.003511	3.67	54.44	29.66	0.48
Reach-1	13.4*	500.00	98.54	102.31	101.81	102.64	0.003646	4.98	171.97	217.95	0.52
Reach-1	13.4*	750.00	98.54	102.72	102.47	103.07	0.003786	5.56	278.19	300.77	0.54
Reach-1	13.4*	1000.00	98.54	103.02	102.79	103.38	0.003849	5.95	379.54	362.56	0.56
Reach-1	13.4*	1500.00	98.54	103.45	103.29	103.81	0.003932	6.49	545.47	399.00	0.57
Reach-1	13.2*	10.00	98.24	99.26	98.62	99.27	0.000575	0.86	11.64	14.59	0.17
Reach-1	13.2*	20.00	98.24	99.49	98.79	99.52	0.001046	1.32	15.20	15.67	0.24
Reach-1	13.2*	30.00	98.24	99.67	98.93	99.71	0.001442	1.66	18.05	16.64	0.28
Reach-1	13.2*	40.00	98.24	99.82	99.05	99.87	0.001798	1.94	20.57	17.66	0.32
Reach-1	13.2*	50.00	98.24	99.95	99.16	100.02	0.002090	2.18	22.95	18.57	0.35
Reach-1	13.2*	60.00	98.24	100.07	99.26	100.16	0.002368	2.38	25.25	19.69	0.37
Reach-1	13.2*	70.00	98.24	100.18	99.36	100.28	0.002672	2.54	27.55	21.31	0.39
Reach-1	13.2*	80.00	98.24	100.29	99.45	100.40	0.002902	2.67	29.94	22.86	0.41
Reach-1	13.2*	90.00	98.24	100.39	99.53	100.51	0.003080	2.78	32.36	24.33	0.43
Reach-1	13.2*	100.00	98.24	100.49	99.61	100.62	0.003213	2.87	34.79	25.73	0.44
Reach-1	13.2*	200.00	98.24	101.24	100.32	101.44	0.003328	3.57	55.96	30.32	0.46
Reach-1	13.2*	500.00	98.24	102.25	101.67	102.56	0.003419	4.82	178.54	222.97	0.50
Reach-1	13.2*	750.00	98.24	102.66	102.36	102.99	0.003557	5.38	287.05	305.81	0.53
Reach-1	13.2*	1000.00	98.24	102.96	102.69	103.30	0.003681	5.80	386.98	365.87	0.54
Reach-1	13.2*	1500.00	98.24	103.38	103.20	103.73	0.003796	6.35	551.98	399.00	0.56
Reach-1	13.*	10.00	97.94	99.25	98.32	99.26	0.000252	0.67	14.95	14.40	0.12
Reach-1	13.*	20.00	97.94	99.48	98.50	99.50	0.000554	1.09	18.37	15.29	0.18
Reach-1	13.*	30.00	97.94	99.66	98.65	99.69	0.000851	1.42	21.07	16.15	0.22
Reach-1	13.*	40.00	97.94	99.80	98.77	99.84	0.001143	1.71	23.42	17.01	0.26
Reach-1	13.*	50.00	97.94	99.92	98.89	99.98	0.001406	1.95	25.62	17.79	0.29
Reach-1	13.*	60.00	97.94	100.04	99.00	100.11	0.001642	2.16	27.73	18.49	0.31
Reach-1	13.*	70.00	97.94	100.15	99.10	100.23	0.001909	2.35	29.74	19.58	0.34
Reach-1	13.*	80.00	97.94	100.25	99.19	100.35	0.002185	2.52	31.80	21.02	0.36
Reach-1	13.*	90.00	97.94	100.34	99.28	100.45	0.002427	2.66	33.90	22.39	0.38
Reach-1	13.*	100.00	97.94	100.44	99.36	100.56	0.002633	2.78	36.03	23.69	0.40
Reach-1	13.*	200.00	97.94	101.18	100.08	101.37	0.003347	3.53	56.58	30.97	0.46

Reach-1	13.*	500.00	97.94	102.20	101.60	102.48	0.003296	4.69	184.90	228.71	0.49
Reach-1	13.*	750.00	97.94	102.60	102.27	102.91	0.003436	5.24	294.73	310.94	0.51
Reach-1	13.*	1000.00	97.94	102.90	102.60	103.22	0.003539	5.64	396.96	371.48	0.53
Reach-1	13.*	1500.00	97.94	103.32	103.11	103.65	0.003633	6.16	563.04	399.00	0.55
Reach-1	12.8	10.00	97.64	99.25	98.02	99.25	0.000140	0.56	17.88	14.08	0.09
Reach-1	12.8	20.00	97.64	99.48	98.21	99.49	0.000345	0.94	21.17	14.85	0.14
Reach-1	12.8	30.00	97.64	99.65	98.37	99.67	0.000572	1.26	23.73	15.65	0.18
Reach-1	12.8	40.00	97.64	99.78	98.50	99.82	0.000806	1.54	25.94	16.42	0.22
Reach-1	12.8	50.00	97.64	99.91	98.63	99.96	0.001034	1.79	27.99	17.10	0.25
Reach-1	12.8	60.00	97.64	100.02	98.74	100.08	0.001249	2.00	29.94	17.73	0.27
Reach-1	12.8	70.00	97.64	100.12	98.84	100.20	0.001456	2.20	31.77	18.30	0.29
Reach-1	12.8	80.00	97.64	100.22	98.94	100.30	0.001709	2.38	33.58	19.44	0.32
Reach-1	12.8	90.00	97.64	100.31	99.03	100.41	0.001963	2.54	35.40	20.68	0.34
Reach-1	12.8	100.00	97.64	100.39	99.12	100.51	0.002196	2.68	37.25	21.86	0.36
Reach-1	12.8	200.00	97.64	101.11	99.88	101.30	0.003560	3.55	56.29	31.55	0.47
Reach-1	12.8	500.00	97.64	102.14	101.58	102.41	0.003269	4.59	190.15	233.63	0.48
Reach-1	12.8	750.00	97.64	102.55	102.19	102.83	0.003383	5.11	301.58	315.48	0.50
Reach-1	12.8	1000.00	97.64	102.85	102.51	103.15	0.003453	5.49	406.31	376.52	0.52
Reach-1	12.8	1500.00	97.64	103.27	103.02	103.57	0.003524	5.98	572.96	399.00	0.53
Reach-1	12.6*	10.00	97.89	99.25	98.27	99.25	0.000207	0.62	16.23	15.34	0.11
Reach-1	12.6*	20.00	97.89	99.47	98.44	99.48	0.000475	1.01	19.74	16.46	0.16
Reach-1	12.6*	30.00	97.89	99.63	98.59	99.66	0.000752	1.33	22.50	17.51	0.21
Reach-1	12.6*	40.00	97.89	99.76	98.71	99.80	0.001021	1.61	24.87	18.36	0.24
Reach-1	12.6*	50.00	97.89	99.88	98.82	99.93	0.001283	1.85	27.07	19.26	0.27
Reach-1	12.6*	60.00	97.89	99.99	98.93	100.05	0.001585	2.05	29.22	20.80	0.31
Reach-1	12.6*	70.00	97.89	100.08	99.02	100.16	0.001863	2.23	31.33	22.22	0.33
Reach-1	12.6*	80.00	97.89	100.18	99.11	100.27	0.002112	2.39	33.45	23.55	0.35
Reach-1	12.6*	90.00	97.89	100.26	99.20	100.36	0.002334	2.53	35.56	24.80	0.37
Reach-1	12.6*	100.00	97.89	100.35	99.28	100.46	0.002520	2.65	37.68	25.95	0.39
Reach-1	12.6*	200.00	97.89	101.05	100.01	101.23	0.003137	3.48	57.51	30.90	0.45
Reach-1	12.6*	500.00	97.89	102.08	101.42	102.35	0.003019	4.57	194.21	236.78	0.47
Reach-1	12.6*	750.00	97.89	102.47	102.12	102.77	0.003242	5.16	303.20	316.45	0.50
Reach-1	12.6*	1000.00	97.89	102.77	102.45	103.08	0.003378	5.58	405.47	376.17	0.52
Reach-1	12.6*	1500.00	97.89	103.18	102.96	103.49	0.003533	6.13	568.26	399.00	0.54
Reach-1	12.4*	10.00	98.13	99.24	98.52	99.25	0.000378	0.72	13.88	16.67	0.14
Reach-1	12.4*	20.00	98.13	99.45	98.68	99.47	0.000781	1.14	17.61	18.42	0.20
Reach-1	12.4*	30.00	98.13	99.61	98.81	99.64	0.001166	1.46	20.57	19.93	0.25
Reach-1	12.4*	40.00	98.13	99.73	98.93	99.78	0.001570	1.73	23.18	21.82	0.30
Reach-1	12.4*	50.00	98.13	99.84	99.03	99.90	0.001917	1.94	25.71	23.50	0.33
Reach-1	12.4*	60.00	98.13	99.94	99.13	100.01	0.002210	2.13	28.19	25.04	0.35
Reach-1	12.4*	70.00	98.13	100.04	99.22	100.12	0.002386	2.29	30.59	25.82	0.37
Reach-1	12.4*	80.00	98.13	100.13	99.30	100.22	0.002503	2.43	32.93	26.30	0.38
Reach-1	12.4*	90.00	98.13	100.21	99.39	100.31	0.002598	2.56	35.17	26.67	0.39
Reach-1	12.4*	100.00	98.13	100.29	99.46	100.41	0.002678	2.68	37.35	27.02	0.40
Reach-1	12.4*	200.00	98.13	100.98	100.08	101.17	0.003092	3.52	56.84	29.99	0.45
Reach-1	12.4*	500.00	98.13	102.01	101.41	102.28	0.002978	4.62	196.12	239.49	0.48
Reach-1	12.4*	750.00	98.13	102.40	102.07	102.70	0.003251	5.24	303.38	317.57	0.51
Reach-1	12.4*	1000.00	98.13	102.69	102.38	103.01	0.003426	5.68	403.57	376.14	0.53
Reach-1	12.4*	1500.00	98.13	103.09	102.89	103.42	0.003617	6.27	563.72	399.00	0.55
Reach-1	12.2*	10.00	98.38	99.22	98.78	99.23	0.001060	0.95	10.57	18.53	0.22
Reach-1	12.2*	20.00	98.38	99.42	98.93	99.45	0.001810	1.38	14.52	21.63	0.30
Reach-1	12.2*	30.00	98.38	99.56	99.06	99.60	0.002392	1.68	17.81	24.17	0.35
Reach-1	12.2*	40.00	98.38	99.68	99.17	99.73	0.002733	1.93	20.68	25.20	0.38
Reach-1	12.2*	50.00	98.38	99.78	99.26	99.85	0.002949	2.14	23.35	25.83	0.40
Reach-1	12.2*	60.00	98.38	99.88	99.35	99.96	0.003080	2.32	25.85	26.11	0.41

Reach-1	12.2*	70.00	98.38	99.97	99.43	100.06	0.003183	2.48	28.22	26.36	0.42
Reach-1	12.2*	80.00	98.38	100.05	99.51	100.16	0.003254	2.62	30.52	26.61	0.43
Reach-1	12.2*	90.00	98.38	100.14	99.58	100.25	0.003316	2.75	32.71	26.84	0.44
Reach-1	12.2*	100.00	98.38	100.22	99.64	100.34	0.003362	2.87	34.84	27.06	0.45
Reach-1	12.2*	200.00	98.38	100.89	100.11	101.10	0.003583	3.73	53.60	28.96	0.48
Reach-1	12.2*	500.00	98.38	101.92	101.48	102.22	0.003300	4.82	190.06	236.67	0.50
Reach-1	12.2*	750.00	98.38	102.31	102.03	102.63	0.003546	5.43	296.22	314.74	0.53
Reach-1	12.2*	1000.00	98.38	102.60	102.35	102.93	0.003704	5.87	395.21	373.11	0.55
Reach-1	12.2*	1500.00	98.38	103.00	102.83	103.34	0.003866	6.44	554.91	399.00	0.57
Reach-1	12	10.00	98.62	99.13	99.04	99.18	0.011058	1.86	5.37	19.93	0.63
Reach-1	12	20.00	98.62	99.30	99.17	99.37	0.009285	2.18	9.19	23.63	0.61
Reach-1	12	30.00	98.62	99.42	99.27	99.52	0.008709	2.45	12.24	25.05	0.62
Reach-1	12	40.00	98.62	99.53	99.36	99.64	0.008215	2.68	14.94	25.56	0.62
Reach-1	12	50.00	98.62	99.63	99.43	99.76	0.007678	2.86	17.51	25.75	0.61
Reach-1	12	60.00	98.62	99.72	99.50	99.87	0.007271	3.01	19.94	25.93	0.60
Reach-1	12	70.00	98.62	99.81	99.56	99.97	0.006960	3.15	22.24	26.10	0.60
Reach-1	12	80.00	98.62	99.90	99.61	100.07	0.006659	3.26	24.51	26.26	0.60
Reach-1	12	90.00	98.62	99.98	99.67	100.16	0.006443	3.38	26.66	26.42	0.59
Reach-1	12	100.00	98.62	100.06	99.72	100.25	0.006247	3.48	28.75	26.56	0.59
Reach-1	12	200.00	98.62	100.73	100.18	101.01	0.005370	4.27	46.84	27.82	0.58
Reach-1	12	500.00	98.62	101.71	101.55	102.12	0.005086	5.62	154.42	208.47	0.61
Reach-1	12	750.00	98.62	102.14	102.02	102.54	0.004732	6.00	264.83	297.25	0.60
Reach-1	12	1000.00	98.62	102.48	102.30	102.85	0.004407	6.20	375.36	365.11	0.59
Reach-1	12	1500.00	98.62	102.91	102.76	103.26	0.004230	6.58	546.56	399.00	0.59
Reach-1	11.8*	10.00	98.32	98.83	98.77	98.92	0.015790	2.38	4.19	14.00	0.77
Reach-1	11.8*	20.00	98.32	99.00	98.93	99.13	0.015666	2.89	6.93	17.24	0.80
Reach-1	11.8*	30.00	98.32	99.17	99.07	99.31	0.012858	2.96	10.14	20.94	0.75
Reach-1	11.8*	40.00	98.32	99.32	99.16	99.46	0.010288	2.98	13.41	23.06	0.69
Reach-1	11.8*	50.00	98.32	99.45	99.25	99.59	0.008728	3.01	16.63	24.98	0.65
Reach-1	11.8*	60.00	98.32	99.57	99.33	99.71	0.007715	3.05	19.67	26.30	0.62
Reach-1	11.8*	70.00	98.32	99.68	99.40	99.83	0.006845	3.11	22.52	26.69	0.60
Reach-1	11.8*	80.00	98.32	99.78	99.46	99.93	0.006254	3.18	25.17	26.87	0.58
Reach-1	11.8*	90.00	98.32	99.87	99.53	100.03	0.005905	3.26	27.58	27.04	0.57
Reach-1	11.8*	100.00	98.32	99.95	99.58	100.13	0.005628	3.34	29.91	27.20	0.56
Reach-1	11.8*	200.00	98.32	100.65	100.03	100.90	0.004682	4.06	49.21	28.49	0.55
Reach-1	11.8*	500.00	98.32	101.63	101.39	102.02	0.004618	5.43	158.12	209.59	0.58
Reach-1	11.8*	750.00	98.32	102.05	101.90	102.44	0.004530	5.92	264.14	294.89	0.59
Reach-1	11.8*	1000.00	98.32	102.37	102.20	102.75	0.004402	6.23	367.87	359.26	0.59
Reach-1	11.8*	1500.00	98.32	102.81	102.67	103.17	0.004253	6.63	539.73	399.00	0.59
Reach-1	11.6*	10.00	98.02	98.52	98.46	98.61	0.014678	2.44	4.09	12.43	0.75
Reach-1	11.6*	20.00	98.02	98.77	98.63	98.88	0.009581	2.66	7.51	14.47	0.65
Reach-1	11.6*	30.00	98.02	98.97	98.76	99.10	0.008225	2.83	10.58	16.54	0.62
Reach-1	11.6*	40.00	98.02	99.14	98.88	99.28	0.007821	2.96	13.53	19.08	0.62
Reach-1	11.6*	50.00	98.02	99.29	98.99	99.43	0.007338	3.01	16.63	21.76	0.61
Reach-1	11.6*	60.00	98.02	99.43	99.09	99.57	0.006771	3.05	19.66	23.67	0.59
Reach-1	11.6*	70.00	98.02	99.55	99.19	99.70	0.006326	3.09	22.66	25.41	0.58
Reach-1	11.6*	80.00	98.02	99.66	99.27	99.81	0.005954	3.13	25.54	26.80	0.57
Reach-1	11.6*	90.00	98.02	99.76	99.34	99.91	0.005628	3.19	28.22	27.60	0.56
Reach-1	11.6*	100.00	98.02	99.85	99.41	100.01	0.005229	3.24	30.85	27.78	0.54
Reach-1	11.6*	200.00	98.02	100.57	99.91	100.81	0.004182	3.89	51.38	29.16	0.52
Reach-1	11.6*	500.00	98.02	101.56	101.24	101.92	0.004218	5.24	163.24	212.75	0.56
Reach-1	11.6*	750.00	98.02	101.98	101.80	102.35	0.004249	5.78	268.68	296.81	0.57
Reach-1	11.6*	1000.00	98.02	102.29	102.10	102.66	0.004191	6.11	371.83	360.56	0.58
Reach-1	11.6*	1500.00	98.02	102.72	102.58	103.08	0.004202	6.61	538.01	399.00	0.59
Reach-1	11.4*	10.00	97.73	98.46	98.15	98.49	0.002630	1.42	7.02	13.05	0.34

Reach-1	11.4*	20.00	97.73	98.71	98.32	98.77	0.003243	1.91	10.44	14.50	0.40
Reach-1	11.4*	30.00	97.73	98.90	98.47	98.98	0.003640	2.25	13.36	15.86	0.43
Reach-1	11.4*	40.00	97.73	99.06	98.60	99.16	0.003982	2.50	15.97	17.18	0.46
Reach-1	11.4*	50.00	97.73	99.20	98.70	99.31	0.004390	2.71	18.48	19.03	0.48
Reach-1	11.4*	60.00	97.73	99.33	98.80	99.45	0.004785	2.85	21.03	21.34	0.51
Reach-1	11.4*	70.00	97.73	99.45	98.91	99.58	0.004836	2.95	23.72	23.05	0.51
Reach-1	11.4*	80.00	97.73	99.56	98.99	99.70	0.004850	3.04	26.35	24.59	0.52
Reach-1	11.4*	90.00	97.73	99.66	99.08	99.81	0.004878	3.12	28.86	25.97	0.52
Reach-1	11.4*	100.00	97.73	99.76	99.17	99.91	0.004795	3.17	31.51	27.26	0.52
Reach-1	11.4*	200.00	97.73	100.50	99.79	100.72	0.003864	3.76	53.17	29.86	0.50
Reach-1	11.4*	500.00	97.73	101.50	101.09	101.83	0.003873	5.05	170.22	217.49	0.53
Reach-1	11.4*	750.00	97.73	101.92	101.68	102.26	0.003920	5.58	278.04	301.31	0.55
Reach-1	11.4*	1000.00	97.73	102.22	101.99	102.57	0.003975	5.97	378.53	362.38	0.56
Reach-1	11.4*	1500.00	97.73	102.64	102.49	103.00	0.004053	6.50	543.05	399.00	0.58
Reach-1	11.2*	10.00	97.43	98.45	97.83	98.46	0.000706	0.94	10.65	13.57	0.19
Reach-1	11.2*	20.00	97.43	98.69	98.01	98.72	0.001255	1.42	14.04	14.65	0.26
Reach-1	11.2*	30.00	97.43	98.87	98.16	98.92	0.001702	1.78	16.85	15.75	0.30
Reach-1	11.2*	40.00	97.43	99.02	98.29	99.09	0.002105	2.07	19.31	16.84	0.34
Reach-1	11.2*	50.00	97.43	99.16	98.40	99.24	0.002442	2.31	21.60	17.79	0.37
Reach-1	11.2*	60.00	97.43	99.27	98.51	99.37	0.002865	2.53	23.73	19.30	0.40
Reach-1	11.2*	70.00	97.43	99.38	98.61	99.50	0.003222	2.69	26.00	21.06	0.43
Reach-1	11.2*	80.00	97.43	99.49	98.70	99.61	0.003494	2.83	28.28	22.60	0.45
Reach-1	11.2*	90.00	97.43	99.58	98.79	99.72	0.003720	2.96	30.46	23.91	0.46
Reach-1	11.2*	100.00	97.43	99.68	98.88	99.82	0.003849	3.05	32.82	25.25	0.47
Reach-1	11.2*	200.00	97.43	100.44	99.60	100.64	0.003646	3.65	54.72	30.53	0.48
Reach-1	11.2*	500.00	97.43	101.44	100.96	101.75	0.003635	4.89	175.99	221.91	0.52
Reach-1	11.2*	750.00	97.43	101.86	101.58	102.18	0.003671	5.40	286.82	306.58	0.53
Reach-1	11.2*	1000.00	97.43	102.15	101.89	102.49	0.003800	5.82	385.59	365.88	0.55
Reach-1	11.2*	1500.00	97.43	102.57	102.39	102.91	0.003908	6.37	549.41	399.00	0.57
Reach-1	11.*	10.00	97.13	98.44	97.52	98.45	0.000281	0.70	14.29	13.88	0.12
Reach-1	11.*	20.00	97.13	98.68	97.71	98.70	0.000607	1.13	17.67	14.78	0.18
Reach-1	11.*	30.00	97.13	98.86	97.86	98.89	0.000921	1.47	20.42	15.73	0.23
Reach-1	11.*	40.00	97.13	99.01	97.99	99.05	0.001228	1.76	22.78	16.65	0.26
Reach-1	11.*	50.00	97.13	99.13	98.11	99.20	0.001510	2.00	24.95	17.44	0.30
Reach-1	11.*	60.00	97.13	99.24	98.23	99.32	0.001785	2.23	26.90	18.13	0.32
Reach-1	11.*	70.00	97.13	99.35	98.32	99.44	0.002113	2.42	28.88	19.53	0.35
Reach-1	11.*	80.00	97.13	99.45	98.42	99.55	0.002428	2.59	30.84	20.96	0.38
Reach-1	11.*	90.00	97.13	99.53	98.51	99.65	0.002725	2.75	32.72	22.23	0.40
Reach-1	11.*	100.00	97.13	99.62	98.60	99.75	0.002944	2.87	34.80	23.48	0.42
Reach-1	11.*	200.00	97.13	100.37	99.35	100.57	0.003543	3.58	55.85	31.17	0.47
Reach-1	11.*	500.00	97.13	101.38	100.86	101.67	0.003451	4.75	182.20	227.04	0.50
Reach-1	11.*	750.00	97.13	101.80	101.48	102.10	0.003506	5.25	294.33	311.22	0.52
Reach-1	11.*	1000.00	97.13	102.09	101.80	102.41	0.003633	5.67	394.61	370.65	0.53
Reach-1	11.*	1500.00	97.13	102.51	102.30	102.83	0.003744	6.20	558.61	399.00	0.55
Reach-1	10.8	10.00	96.83	98.44	97.21	98.45	0.000140	0.56	17.90	14.09	0.09
Reach-1	10.8	20.00	96.83	98.67	97.40	98.69	0.000341	0.94	21.27	14.87	0.14
Reach-1	10.8	30.00	96.83	98.85	97.56	98.88	0.000556	1.25	23.99	15.74	0.18
Reach-1	10.8	40.00	96.83	99.00	97.69	99.03	0.000779	1.52	26.29	16.54	0.21
Reach-1	10.8	50.00	96.83	99.12	97.82	99.17	0.000997	1.76	28.38	17.23	0.24
Reach-1	10.8	60.00	96.83	99.22	97.93	99.29	0.001217	1.98	30.24	17.82	0.27
Reach-1	10.8	70.00	96.83	99.33	98.03	99.40	0.001421	2.18	32.07	18.39	0.29
Reach-1	10.8	80.00	96.83	99.42	98.13	99.50	0.001689	2.37	33.80	19.60	0.32
Reach-1	10.8	90.00	96.83	99.50	98.22	99.60	0.001958	2.54	35.44	20.70	0.34
Reach-1	10.8	100.00	96.83	99.58	98.31	99.70	0.002194	2.68	37.26	21.86	0.36
Reach-1	10.8	200.00	96.83	100.30	99.07	100.50	0.003528	3.54	56.51	31.64	0.47
Reach-1	10.8	500.00	96.83	101.32	100.77	101.60	0.003320	4.62	188.27	232.02	0.49

Reach-1	10.8	750.00	96.83	101.74	101.38	102.03	0.003376	5.11	301.96	315.74	0.50
Reach-1	10.8	1000.00	96.83	102.03	101.70	102.33	0.003496	5.51	403.74	375.16	0.52
Reach-1	10.8	1500.00	96.83	102.45	102.21	102.75	0.003606	6.03	567.87	399.00	0.54
Reach-1	10.6*	10.00	97.07	98.44	97.47	98.44	0.000239	0.66	15.25	14.53	0.11
Reach-1	10.6*	20.00	97.07	98.66	97.66	98.68	0.000546	1.07	18.65	15.72	0.17
Reach-1	10.6*	30.00	97.07	98.83	97.80	98.86	0.000851	1.40	21.43	16.87	0.22
Reach-1	10.6*	40.00	97.07	98.97	97.94	99.01	0.001150	1.68	23.77	17.78	0.26
Reach-1	10.6*	50.00	97.07	99.08	98.05	99.14	0.001481	1.93	25.91	19.09	0.29
Reach-1	10.6*	60.00	97.07	99.18	98.16	99.26	0.001842	2.15	27.88	20.56	0.33
Reach-1	10.6*	70.00	97.07	99.28	98.26	99.36	0.002163	2.34	29.92	21.98	0.35
Reach-1	10.6*	80.00	97.07	99.37	98.35	99.46	0.002458	2.51	31.86	23.19	0.38
Reach-1	10.6*	90.00	97.07	99.44	98.44	99.55	0.002747	2.67	33.65	24.25	0.40
Reach-1	10.6*	100.00	97.07	99.52	98.53	99.64	0.002966	2.80	35.68	25.39	0.42
Reach-1	10.6*	200.00	97.07	100.23	99.29	100.43	0.003392	3.55	56.33	30.94	0.46
Reach-1	10.6*	500.00	97.07	101.25	100.70	101.53	0.003253	4.67	188.77	233.04	0.49
Reach-1	10.6*	750.00	97.07	101.66	101.32	101.96	0.003364	5.20	300.90	315.68	0.51
Reach-1	10.6*	1000.00	97.07	101.95	101.64	102.26	0.003531	5.63	400.25	373.95	0.53
Reach-1	10.6*	1500.00	97.07	102.35	102.15	102.68	0.003697	6.20	561.22	399.00	0.55
Reach-1	10.4*	10.00	97.32	98.43	97.74	98.44	0.000503	0.81	12.33	15.31	0.16
Reach-1	10.4*	20.00	97.32	98.64	97.91	98.66	0.001026	1.27	15.80	17.09	0.23
Reach-1	10.4*	30.00	97.32	98.80	98.06	98.84	0.001548	1.61	18.67	19.21	0.29
Reach-1	10.4*	40.00	97.32	98.92	98.18	98.98	0.002079	1.88	21.23	21.49	0.33
Reach-1	10.4*	50.00	97.32	99.03	98.29	99.10	0.002482	2.11	23.66	23.01	0.37
Reach-1	10.4*	60.00	97.32	99.13	98.39	99.21	0.002873	2.32	25.81	24.28	0.40
Reach-1	10.4*	70.00	97.32	99.21	98.49	99.31	0.003173	2.50	28.04	25.53	0.42
Reach-1	10.4*	80.00	97.32	99.29	98.58	99.40	0.003454	2.65	30.13	26.65	0.44
Reach-1	10.4*	90.00	97.32	99.36	98.67	99.49	0.003718	2.81	32.02	27.47	0.46
Reach-1	10.4*	100.00	97.32	99.44	98.76	99.58	0.003843	2.92	34.23	28.39	0.47
Reach-1	10.4*	200.00	97.32	100.15	99.38	100.36	0.003492	3.64	54.92	29.96	0.47
Reach-1	10.4*	500.00	97.32	101.17	100.69	101.46	0.003344	4.78	187.04	233.26	0.50
Reach-1	10.4*	750.00	97.32	101.58	101.28	101.88	0.003462	5.31	298.38	315.74	0.52
Reach-1	10.4*	1000.00	97.32	101.86	101.59	102.19	0.003662	5.78	395.48	373.07	0.54
Reach-1	10.4*	1500.00	97.32	102.26	102.08	102.60	0.003840	6.36	554.73	399.00	0.56
Reach-1	10.2*	10.00	97.56	98.40	98.00	98.42	0.001535	1.09	9.17	17.13	0.26
Reach-1	10.2*	20.00	97.56	98.59	98.17	98.63	0.002600	1.55	12.90	21.05	0.35
Reach-1	10.2*	30.00	97.56	98.74	98.30	98.79	0.003148	1.86	16.15	23.15	0.39
Reach-1	10.2*	40.00	97.56	98.85	98.42	98.92	0.003649	2.12	18.87	24.78	0.43
Reach-1	10.2*	50.00	97.56	98.96	98.53	99.04	0.004002	2.33	21.42	26.06	0.45
Reach-1	10.2*	60.00	97.56	99.04	98.61	99.14	0.004391	2.54	23.58	27.00	0.48
Reach-1	10.2*	70.00	97.56	99.12	98.69	99.24	0.004435	2.70	25.89	27.20	0.49
Reach-1	10.2*	80.00	97.56	99.20	98.76	99.32	0.004552	2.87	27.91	27.34	0.50
Reach-1	10.2*	90.00	97.56	99.26	98.83	99.40	0.004773	3.04	29.60	27.45	0.52
Reach-1	10.2*	100.00	97.56	99.33	98.89	99.49	0.004732	3.15	31.71	27.60	0.52
Reach-1	10.2*	200.00	97.56	100.05	99.35	100.28	0.003986	3.85	52.00	28.95	0.51
Reach-1	10.2*	500.00	97.56	101.08	100.71	101.39	0.003592	4.94	184.04	232.51	0.52
Reach-1	10.2*	750.00	97.56	101.49	101.23	101.81	0.003668	5.45	294.98	314.72	0.53
Reach-1	10.2*	1000.00	97.56	101.77	101.52	102.11	0.003873	5.92	390.50	371.20	0.56
Reach-1	10.2*	1500.00	97.56	102.17	102.01	102.52	0.004041	6.50	548.63	399.00	0.58
Reach-1	10	10.00	97.80	98.22	98.22	98.33	0.029754	2.63	3.81	17.68	1.00
Reach-1	10	20.00	97.80	98.40	98.36	98.51	0.018125	2.71	7.37	22.47	0.84
Reach-1	10	30.00	97.80	98.45	98.45	98.64	0.025527	3.49	8.60	23.26	1.01
Reach-1	10	40.00	97.80	98.54	98.54	98.76	0.023684	3.75	10.65	24.36	1.00
Reach-1	10	50.00	97.80	98.61	98.61	98.86	0.023224	4.03	12.41	25.12	1.01
Reach-1	10	60.00	97.80	98.70	98.68	98.96	0.019618	4.09	14.67	25.54	0.95
Reach-1	10	70.00	97.80	98.74	98.74	99.05	0.021453	4.46	15.69	25.62	1.00

Reach-1	10	80.00	97.80	98.80	98.80	99.13	0.020687	4.64	17.24	25.73	1.00
Reach-1	10	90.00	97.80	99.00	98.85	99.25	0.011214	4.01	22.42	26.11	0.76
Reach-1	10	100.00	97.80	99.10	98.90	99.35	0.009714	3.99	25.04	26.30	0.72
Reach-1	10	200.00	97.80	99.90	99.36	100.18	0.005426	4.28	46.68	27.81	0.58
Reach-1	10	500.00	97.80	100.80	100.73	101.29	0.006079	6.01	136.94	190.66	0.66
Reach-1	10	750.00	97.80	101.30	101.20	101.71	0.004966	6.11	257.58	292.31	0.62
Reach-1	10	1000.00	97.80	101.60	101.48	102.01	0.004919	6.48	354.52	353.31	0.62
Reach-1	10	1500.00	97.80	102.00	101.94	102.42	0.005076	7.09	508.92	399.00	0.64

Reach-averaged hydraulic conditions and computed sediment transport capacities for various design alternatives

Discharge (cfs)	Main Channel Velocity (ft/s)	Hydraulic Depth (ft)	Effective Width (ft)	Energy Slope (ft/ft)	Sediment Transport Capacity (cfs)
Bankfull Discharge = 150 cfs, Average Slope = 0.0016 ft/ft					
10	0.9	0.7	17	0.0007	0.0E+00
20	1.2	0.9	19	0.0010	0.0E+00
30	1.5	1.0	21	0.0012	0.0E+00
40	1.6	1.1	22	0.0013	0.0E+00
50	1.8	1.2	24	0.0014	0.0E+00
60	1.9	1.3	25	0.0014	0.0E+00
70	2.0	1.3	27	0.0014	1.4E-03
80	2.0	1.4	28	0.0015	1.7E-03
90	2.1	1.5	28	0.0015	2.1E-03
100	2.2	1.6	29	0.0015	2.5E-03
200	2.8	2.3	32	0.0014	6.7E-03
500	3.5	3.3	32	0.0014	1.7E-02
750	3.9	3.7	32	0.0014	2.4E-02
1000	4.1	4.0	32	0.0014	3.0E-02
1500	4.5	4.6	32	0.0015	4.2E-02
Bankfull Discharge = 150 cfs, Average Slope = 0.0026 ft/ft					
10	0.9	0.6	17	0.0009	0.0E+00
20	1.3	0.8	19	0.0012	0.0E+00
30	1.6	1.0	20	0.0015	0.0E+00
40	1.8	1.1	21	0.0017	0.0E+00
50	2.0	1.1	22	0.0019	1.4E-03
60	2.1	1.2	24	0.0020	2.3E-03
70	2.3	1.2	25	0.0021	3.2E-03
80	2.4	1.3	26	0.0022	4.0E-03
90	2.5	1.4	27	0.0022	4.9E-03
100	2.6	1.4	27	0.0022	5.5E-03
200	2.8	2.3	30	0.0014	6.3E-03
500	4.2	3.0	30	0.0022	3.9E-02
750	4.6	3.4	30	0.0023	5.8E-02
1000	4.9	3.8	30	0.0022	7.0E-02
1500	5.3	4.2	30	0.0023	1.0E-01
Bankfull Discharge = 150 cfs, Average Slope = 0.0031 ft/ft					
10	1.1	0.6	15	0.0014	0.0E+00
20	1.5	0.7	18	0.0019	0.0E+00
30	1.8	0.9	19	0.0022	9.6E-04
40	2.0	0.9	21	0.0025	1.9E-03
50	2.2	1.0	22	0.0027	2.9E-03
60	2.4	1.1	24	0.0028	4.1E-03
70	2.5	1.1	25	0.0028	5.2E-03
80	2.6	1.2	26	0.0028	6.3E-03
90	2.7	1.3	26	0.0028	7.1E-03
100	2.8	1.3	27	0.0028	8.3E-03
200	3.5	1.9	29	0.0028	2.2E-02
500	4.5	2.9	29	0.0027	5.5E-02
750	4.9	3.3	29	0.0027	7.8E-02
1000	5.2	3.6	29	0.0027	9.3E-02
1500	5.6	4.0	29	0.0028	1.3E-01

Reach-averaged hydraulic conditions and computed sediment transport capacities for various design alternatives

Discharge (cfs)	Main Channel Velocity (ft/s)	Hydraulic Depth (ft)	Effective Width (ft)	Energy Slope (ft/ft)	Sediment Transport Capacity (cfs)
Bankfull Discharge = 150 cfs, Average Slope = 0.0036 ft/ft					
10	1.2	0.6	16	0.0016	0.0E+00
20	1.6	0.7	18	0.0020	0.0E+00
30	1.9	0.9	19	0.0023	1.1E-03
40	2.1	0.9	21	0.0026	2.1E-03
50	2.3	1.0	22	0.0028	3.3E-03
60	2.4	1.1	23	0.0029	4.4E-03
70	2.5	1.1	25	0.0030	5.9E-03
80	2.7	1.2	25	0.0031	7.0E-03
90	2.8	1.3	26	0.0031	8.5E-03
100	2.9	1.3	27	0.0031	9.9E-03
200	3.6	1.9	29	0.0031	2.8E-02
500	4.6	2.8	29	0.0030	6.6E-02
750	5.1	3.2	29	0.0031	9.9E-02
1000	5.5	3.5	29	0.0031	1.3E-01
1500	5.9	3.9	29	0.0032	1.8E-01
Bankfull Discharge = 150 cfs, Average Slope = 0.0041 ft/ft					
10	1.1	0.6	16	0.0015	0.0E+00
20	1.5	0.7	19	0.0020	0.0E+00
30	1.8	0.8	20	0.0023	1.0E-03
40	2.1	0.9	21	0.0026	2.0E-03
50	2.2	1.0	23	0.0029	3.3E-03
60	2.4	1.1	24	0.0030	4.7E-03
70	2.6	1.1	25	0.0031	6.2E-03
80	2.7	1.2	25	0.0032	7.5E-03
90	2.8	1.2	26	0.0032	9.0E-03
100	2.9	1.3	27	0.0033	1.1E-02
200	3.7	1.9	28	0.0032	2.9E-02
500	4.8	2.7	28	0.0033	7.5E-02
750	5.3	3.1	28	0.0035	1.2E-01
1000	5.7	3.4	28	0.0036	1.6E-01
1500	6.2	3.8	28	0.0037	2.2E-01
Bankfull Discharge = 200 cfs, Average Slope = 0.0016 ft/ft					
10	0.7	0.7	19	0.0004	0.0E+00
20	1.0	0.9	21	0.0007	0.0E+00
30	1.3	1.1	22	0.0008	0.0E+00
40	1.5	1.2	24	0.0010	0.0E+00
50	1.6	1.2	25	0.0011	0.0E+00
60	1.7	1.3	26	0.0012	0.0E+00
70	1.9	1.4	27	0.0012	0.0E+00
80	2.0	1.4	29	0.0013	0.0E+00
90	2.0	1.5	30	0.0013	1.7E-03
100	2.1	1.6	31	0.0013	2.0E-03
200	2.6	2.2	35	0.0013	5.5E-03
500	3.5	3.3	35	0.0013	1.7E-02
750	3.8	3.8	35	0.0014	2.5E-02
1000	4.0	4.2	35	0.0013	3.0E-02
1500	4.4	4.7	35	0.0014	4.5E-02

Reach-averaged hydraulic conditions and computed sediment transport capacities for various design alternatives

Discharge (cfs)	Main Channel Velocity (ft/s)	Hydraulic Depth (ft)	Effective Width (ft)	Energy Slope (ft/ft)	Sediment Transport Capacity (cfs)
Bankfull Discharge = 200 cfs, Average Slope = 0.0026 ft/ft					
10	0.8	0.7	18	0.0007	0.0E+00
20	1.2	0.8	20	0.0011	0.0E+00
30	1.5	1.0	21	0.0013	0.0E+00
40	1.7	1.1	22	0.0015	0.0E+00
50	1.9	1.2	23	0.0016	0.0E+00
60	2.0	1.2	24	0.0018	1.7E-03
70	2.2	1.3	25	0.0019	2.4E-03
80	2.3	1.3	26	0.0020	3.2E-03
90	2.4	1.4	27	0.0020	4.2E-03
100	2.5	1.4	28	0.0021	5.1E-03
200	3.2	1.9	33	0.0023	1.5E-02
500	4.2	3.1	34	0.0022	4.4E-02
750	4.6	3.5	34	0.0022	6.5E-02
1000	4.9	3.9	34	0.0022	8.4E-02
1500	5.4	4.3	34	0.0023	1.2E-01
Bankfull Discharge = 200 cfs, Average Slope = 0.0031 ft/ft					
10	1.0	0.6	16	0.0012	0.0E+00
20	1.4	0.8	18	0.0016	0.0E+00
30	1.7	0.9	19	0.0019	0.0E+00
40	2.0	1.0	21	0.0022	1.5E-03
50	2.2	1.1	22	0.0023	2.4E-03
60	2.3	1.1	23	0.0025	3.4E-03
70	2.4	1.2	24	0.0026	4.4E-03
80	2.5	1.2	25	0.0027	5.6E-03
90	2.6	1.3	26	0.0027	6.8E-03
100	2.7	1.4	27	0.0028	7.9E-03
200	3.4	1.9	31	0.0028	2.2E-02
500	4.5	2.9	32	0.0027	6.2E-02
750	5.0	3.4	32	0.0027	9.0E-02
1000	5.3	3.7	32	0.0027	1.1E-01
1500	5.7	4.1	32	0.0027	1.5E-01
Bankfull Discharge = 200 cfs, Average Slope = 0.0036 ft/ft					
10	1.1	0.6	16	0.0014	0.0E+00
20	1.5	0.8	17	0.0018	0.0E+00
30	1.8	0.9	19	0.0022	9.6E-04
40	2.1	1.0	20	0.0024	1.8E-03
50	2.3	1.1	21	0.0026	3.0E-03
60	2.4	1.1	22	0.0028	4.3E-03
70	2.6	1.2	23	0.0030	5.8E-03
80	2.7	1.2	24	0.0031	7.3E-03
90	2.8	1.3	25	0.0032	8.9E-03
100	2.9	1.3	26	0.0032	1.1E-02
200	3.6	1.8	30	0.0032	2.9E-02
500	4.8	2.9	31	0.0031	8.2E-02
750	5.3	3.3	31	0.0031	1.2E-01
1000	5.6	3.6	31	0.0032	1.5E-01
1500	6.1	4.1	31	0.0031	2.0E-01

Reach-averaged hydraulic conditions and computed sediment transport capacities for various design alternatives

Discharge (cfs)	Main Channel Velocity (ft/s)	Hydraulic Depth (ft)	Effective Width (ft)	Energy Slope (ft/ft)	Sediment Transport Capacity (cfs)
Bankfull Discharge = 200 cfs, Average Slope = 0.0041 ft/ft					
10	1.1	0.6	15	0.0015	0.0E+00
20	1.6	0.7	17	0.0021	0.0E+00
30	1.9	0.9	19	0.0024	1.2E-03
40	2.1	0.9	20	0.0027	2.2E-03
50	2.3	1.0	21	0.0029	3.5E-03
60	2.5	1.1	22	0.0031	5.1E-03
70	2.7	1.1	23	0.0033	6.7E-03
80	2.8	1.2	24	0.0034	8.4E-03
90	2.9	1.2	25	0.0035	1.1E-02
100	3.0	1.3	26	0.0036	1.3E-02
200	3.8	1.8	30	0.0036	3.6E-02
500	5.0	2.8	30	0.0035	9.6E-02
750	5.5	3.2	30	0.0035	1.4E-01
1000	5.9	3.5	30	0.0036	1.8E-01
1500	6.4	3.9	30	0.0037	2.7E-01

HEC-RAS MODEL INPUT PARAMTERS FOR SILVER BOW SSTOU SUBAREA 1, REACH A

When analyzing a set of channel/floodplain geometry data, the primary input parameters for the HEC-RAS hydraulic modeling program are:

1. The discharges which are routed through the channel
2. The upstream and downstream boundary conditions when using mixed flow (super and sub-critical) analysis, and
3. The channel/floodplain roughness values (Manning's n).

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1. The discharges used for analyzing the proposed condition channel/floodplain geometry were:

Discharge (cfs)	*Approximate return period(years)*
50	**-**
150	**-**
230	**2**
440	**5**
610	**10**
780	**20**
1042	**50**
2330	**100**

These discharges were based on the hydrologic analysis in the "Channel Stability Analysis for Silver Bow Creek SSTOU Subarea 1" by MEI and Inter-Fluve (1997).

2. The boundary conditions for mixed flow analysis must be set for both upstream and downstream. Boundary conditions are needed to establish the starting water surface at the ends of the river system. At the upstream end of Reach A, the Normal Depth boundary condition was used. There was no other information available about the upstream hydraulic conditions, therefore the **Upstream Normal Depth Slope entering Reach A was estimated to be 0.0034.** This was based on the channel bed slope of Lower Area One (LAO), and the fact that channel bed slope is often an accurate approximation of the water surface profiles during higher flows. In order to accurately model the downstream end of the proposed channel conditions, the proposed channel model was tied into the existing channel model at end of the construction reach (HEC station 901). The existing channel model was extended ~4100 ft downstream in order to negate any effect of downstream boundary conditions. **The Downstream Normal Depth boundary condition was set at S=0.0034.**

3. The **channel roughness was set at 0.035 and the floodplain roughness was set at 0.06.** These channel value is standard for the bed/bank material and alignment of Silver Bow Creek (see Open-Channel Hydraulics by Chow, 1959). The floodplain value was chosen to best represent average roughness conditions in the overbanks for a range of overbank flows. Complete justification of the selection of these values can be found in MEI tech memo dated January 22, 1998.

Silver Bow Creek SSTOU, Reach A Proposed Channel Design, 50 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
976	-62	50	33.47	5414.05	1.55	0.07	31.2	1.51
975	0	50	31	5413.97	1.47	0.09	27.78	1.61
974.5	Bridge							
974	53	50	28.71	5413.69	1.39	0.1	27.58	1.74
973.5	Bridge							
973	123	50	24.18	5413.22	1.22	0.15	27.19	2.07
972	231	50	23.56	5412.9	1.2	0.16	27.13	2.12
971	333	50	22.05	5412.54	1.14	0.19	27	2.27
970.2	465	50	23.74	5412.1	1.2	0.16	27.15	2.11
970.19	633	50	23.37	5411.59	1.19	0.17	27.12	2.14
970.184	759	50	23.57	5411.2	1.2	0.16	27.13	2.12
970.183	791	50	23.65	5411.1	1.2	0.16	27.14	2.11
970.1821	830	50	22.77	5410.97	1.17	0.18	27.06	2.2
970.182	831	50	22.68	5410.97	1.17	0.18	27.05	2.2
970.181	891	50	22.01	5410.74	1.14	0.19	27	2.27
970.1809	892	50	21.91	5410.74	1.14	0.19	26.99	2.28
970.18	934	50	23.65	5410.6	1.2	0.16	27.14	2.11
961	1000	50	22.86	5410.4	1.17	0.18	26.89	2.19
960	1100	50	23.12	5410.07	1.18	0.17	26.91	2.16
959	1200	50	24.44	5409.78	1.23	0.15	26.99	2.05
958	1300	50	12.57	5408.99	0.78	0.69	25.13	3.98
957	1400	50	24.82	5408.65	1.88	0.12	15.41	2.01
956	1500	50	28.65	5408.55	2.12	0.09	16.57	1.75
955	1600	50	22.81	5408.36	1.17	0.18	26.89	2.19
954	1700	50	22.78	5408.02	1.17	0.18	26.89	2.19
953	1800	50	22.85	5407.68	1.17	0.18	26.89	2.19
952	1900	50	23.13	5407.35	1.18	0.17	26.91	2.16
951	2000	50	24.48	5407.06	1.23	0.15	26.99	2.04
950	2100	50	12.46	5406.27	0.78	0.71	25.08	4.01
949	2200	50	23.77	5405.86	1.81	0.14	15.07	2.1
948	2300	50	27.29	5405.75	2.04	0.1	16.17	1.83
947	2400	50	12.77	5405.26	0.79	0.67	25.22	3.92
946	2500	50	27.14	5405.06	2.03	0.1	16.12	1.84
945	2600	50	14.15	5404.64	0.85	0.53	25.82	3.53
944	2700	50	29.2	5404.51	2.16	0.09	16.74	1.71
943	2800	50	24.41	5404.34	1.23	0.15	26.99	2.05
942	2900	50	12.77	5403.56	0.79	0.67	25.22	3.92
941	3000	50	27.31	5403.37	2.04	0.1	16.18	1.83
940	3100	50	12.59	5402.87	0.78	0.69	25.14	3.97
939	3200	50	23.8	5402.47	1.82	0.14	15.08	2.1
938	3300	50	27.31	5402.35	2.04	0.1	16.18	1.83
937	3400	50	12.59	5401.85	0.78	0.69	25.14	3.97
936	3500	50	27.91	5401.71	2.08	0.1	16.35	1.79
935	3600	50	32.46	5401.64	2.35	0.07	17.66	1.54
934	3700	50	31.63	5401.55	1.5	0.08	27.45	1.58
933	3790	50	39.28	5401.48	1.77	0.05	27.92	1.27
932.75	3815	50	20.85	5401.39	1.76	0.17	27.9	2.4
932.6	Culvert							
932.25	3885	50	12.47	5400.54	1.08	0.57	26.73	4.01
932	3910	50	22.24	5400.52	1.15	0.19	26.85	2.25
931	4000	50	23.1	5400.21	1.18	0.17	26.91	2.16

930	4100	50	24.41	5399.92	1.23	0.15	26.99	2.05
929	4200	50	12.77	5399.14	0.79	0.67	25.22	3.92
928	4300	50	21.23	5398.55	1.64	0.18	14.72	2.36
927	4400	50	23.8	5398.39	1.82	0.14	15.08	2.1
926	4500	50	27.31	5398.27	2.04	0.1	16.18	1.83
925	4600	50	12.57	5397.77	0.78	0.69	25.13	3.98
924	4700	50	22.01	5397.25	1.7	0.16	14.82	2.27
923	4800	50	24.9	5397.1	1.89	0.12	15.43	2.01
922	4900	50	28.74	5397	2.13	0.09	16.6	1.74
921	5000	50	23.12	5396.81	1.18	0.17	26.91	2.16
920	5100	50	24.44	5396.52	1.23	0.15	26.99	2.05
919	5200	50	12.57	5395.73	0.78	0.69	25.13	3.98
918	5300	50	25.28	5395.42	1.91	0.12	15.55	1.98
917	5400	50	29.22	5395.33	2.16	0.09	16.74	1.71
916	5500	50	24.44	5395.16	1.23	0.15	26.99	2.05
915	5600	50	12.59	5394.37	0.78	0.69	25.14	3.97
914	5700	50	27.31	5394.19	2.04	0.1	16.18	1.83
913	5800	50	12.57	5393.69	0.78	0.69	25.13	3.98
912	5900	50	23.68	5393.28	1.81	0.14	15.04	2.11
911	6000	50	27.17	5393.16	2.03	0.1	16.13	1.84
910	6100	50	13.53	5392.71	0.82	0.59	25.55	3.7
909	6200	50	28.75	5392.58	2.13	0.09	16.6	1.74
908	6300	50	23.13	5392.39	1.18	0.17	26.91	2.16
907	6400	50	24.48	5392.1	1.23	0.15	26.99	2.04
906	6500	50	12.33	5391.3	0.77	0.72	25.02	4.06
905	6600	50	27.13	5391.12	2.03	0.1	16.12	1.84
904	6700	50	14.57	5390.71	0.86	0.5	25.99	3.43
903	6800	50	29.51	5390.58	2.17	0.09	16.82	1.69
902	6900	50	25.19	5390.43	1.26	0.14	27.04	1.99
901	7000	50	29.66	5390.25	1.42	0.1	27.32	1.69
90	7072	50	18.27	5389.97	1.57	0.3	27.54	2.74
89	7301	50	25.42	5389.23	1.43	0.13	23.07	1.97
88	7531	50	23.01	5388.77	1.87	0.15	16.97	2.17
87	7703	50	23.2	5388.4	1.5	0.16	21.98	2.16
86	7872	50	17.5	5387.74	1.34	0.29	19.16	2.86
85	8160	50	24.88	5387.03	1.93	0.13	17.61	2.01
84	8388	50	19.39	5386.4	1.8	0.25	23.25	2.58
83	8670	50	24.79	5385.61	1.41	0.14	21.59	2.02
82	8988	50	29.05	5385.08	2.78	0.1	26	1.72
81	9255	50	28.07	5384.64	1.64	0.11	27.1	1.78
80	9514	50	27.04	5384.14	1.54	0.12	27.84	1.85
79	9745	50	29.47	5383.83	2.33	0.09	20.17	1.7
78	9998	50	31.18	5383.55	2.15	0.08	25.36	1.6
77	10343	50	26.25	5382.98	1.18	0.13	29	1.9
76	10568	50	30.23	5382.62	1.72	0.09	24.61	1.65
75	10886	50	16.28	5381.71	0.91	0.37	22.08	3.07
74.8	10976	50	36.49	5381.64	1.78	0.06	25.54	1.37
74.7	11026	50	35.69	5381.61	2.31	0.06	22.34	1.4
74.5	Bridge							
74.3	11061	50	20.22	5381.46	1.26	0.23	27.21	2.47
74	11136	50	18.44	5381.1	1.4	0.25	17.52	2.71
73	11187	50	23.3	5380.94	1.24	0.17	27.97	2.15

Silver Bow Creek SSTOU, Reach A Proposed Channel Design, 150 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
976	-62	150	71.08	5415	2.5	0.15	46.69	2.36
975	0	150	57.24	5414.88	2.38	0.19	29.95	2.62
974.5	Bridge							
974	53	150	53.9	5414.57	2.27	0.22	29.68	2.78
973.5	Bridge							
973	123	150	47.91	5414.06	2.06	0.29	29.19	3.13
972	231	150	46.75	5413.72	2.02	0.31	29.1	3.21
971	333	150	45.19	5413.37	1.97	0.33	28.97	3.32
970.2	465	150	47.54	5412.95	2.05	0.3	29.16	3.16
970.19	633	150	46.76	5412.42	2.02	0.31	29.1	3.21
970.184	759	150	46.72	5412.02	2.02	0.31	29.1	3.21
970.183	791	150	46.65	5411.92	2.02	0.31	29.09	3.22
970.1821	830	150	45.53	5411.78	1.98	0.33	29	3.29
970.182	831	150	45.43	5411.78	1.98	0.33	28.99	3.3
970.181	891	150	44.99	5411.56	1.96	0.34	28.95	3.33
970.1809	892	150	44.89	5411.56	1.96	0.34	28.95	3.34
970.18	934	150	46.87	5411.43	2.03	0.31	29.11	3.2
961	1000	150	45.34	5411.22	1.99	0.33	28.29	3.31
960	1100	150	45.09	5410.87	1.98	0.33	28.28	3.33
959	1200	150	44.5	5410.51	1.96	0.34	28.24	3.37
958	1300	150	42.67	5410.1	1.89	0.38	28.13	3.52
957	1400	150	46.33	5409.78	3.01	0.31	25.31	3.24
956	1500	150	48.03	5409.5	3.07	0.28	26.2	3.12
955	1600	150	45.44	5409.18	1.99	0.33	28.3	3.3
954	1700	150	45.4	5408.84	1.99	0.33	28.29	3.3
953	1800	150	45.32	5408.5	1.99	0.33	28.29	3.31
952	1900	150	45.07	5408.15	1.98	0.33	28.27	3.33
951	2000	150	44.38	5407.78	1.95	0.35	28.23	3.38
950	2100	150	42.27	5407.37	1.88	0.39	28.1	3.55
949	2200	150	45.73	5407.03	2.98	0.31	24.98	3.28
948	2300	150	47.13	5406.75	3.04	0.3	25.73	3.18
947	2400	150	43.23	5406.38	1.91	0.37	28.16	3.47
946	2500	150	47.26	5406.07	3.04	0.29	25.8	3.17
945	2600	150	43.56	5405.71	1.92	0.36	28.18	3.44
944	2700	150	47.74	5405.41	3.06	0.29	26.05	3.14
943	2800	150	44.75	5405.08	1.97	0.34	28.26	3.35
942	2900	150	43.48	5404.69	1.92	0.36	28.18	3.45
941	3000	150	47.61	5404.39	3.06	0.29	25.98	3.15
940	3100	150	44.43	5404.05	1.96	0.34	28.24	3.38
939	3200	150	49.06	5403.76	3.11	0.27	26.73	3.06
938	3300	150	52.03	5403.53	3.22	0.24	28.2	2.88
937	3400	150	52.53	5403.31	2.24	0.23	28.72	2.86
936	3500	150	61.11	5403.15	3.52	0.17	35.93	2.46
935	3600	150	74.38	5403.04	3.75	0.13	81.65	2.18
934	3700	150	97.77	5402.96	2.91	0.1	130.5	1.99
933	3790	150	105.15	5402.92	3.21	0.08	191.83	1.73
932.75	3815	150	37.25	5402.67	3.04	0.39	158.46	4.03
932.6	Culvert							
932.25	3885	150	21.36	5401.2	1.74	1.47	27.87	7.02
932	3910	150	44.39	5401.32	1.95	0.34	28.23	3.38
931	4000	150	45.01	5401.01	1.98	0.33	28.27	3.33

930	4100	150	44.2	5400.64	1.95	0.35	28.22	3.39
929	4200	150	41.56	5400.2	1.85	0.4	28.06	3.61
928	4300	150	44.59	5399.85	2.94	0.33	24.35	3.36
927	4400	150	45.43	5399.54	2.97	0.32	24.81	3.3
926	4500	150	46.67	5399.25	3.02	0.3	25.48	3.21
925	4600	150	41.9	5398.86	1.87	0.39	28.08	3.58
924	4700	150	45.14	5398.51	2.96	0.32	24.66	3.32
923	4800	150	46.22	5398.21	3	0.31	25.25	3.25
922	4900	150	47.88	5397.94	3.07	0.29	26.12	3.13
921	5000	150	45.09	5397.61	1.98	0.33	28.28	3.33
920	5100	150	44.45	5397.25	1.96	0.34	28.24	3.37
919	5200	150	42.51	5396.84	1.89	0.38	28.12	3.53
918	5300	150	46.1	5396.51	3	0.31	25.18	3.25
917	5400	150	47.69	5396.23	3.06	0.29	26.02	3.15
916	5500	150	44.58	5395.89	1.96	0.34	28.25	3.36
915	5600	150	42.97	5395.49	1.9	0.37	28.15	3.49
914	5700	150	46.82	5395.18	3.03	0.3	25.56	3.2
913	5800	150	42.34	5394.79	1.88	0.38	28.11	3.54
912	5900	150	45.85	5394.46	2.99	0.31	25.04	3.27
911	6000	150	47.32	5394.18	3.05	0.29	25.83	3.17
910	6100	150	43.7	5393.82	1.93	0.36	28.19	3.43
909	6200	150	47.95	5393.52	3.07	0.29	26.15	3.13
908	6300	150	45.23	5393.19	1.98	0.33	28.28	3.32
907	6400	150	44.89	5392.84	1.97	0.34	28.26	3.34
906	6500	150	43.82	5392.46	1.93	0.36	28.2	3.42
905	6600	150	48.13	5392.17	3.08	0.28	26.25	3.12
904	6700	150	45.62	5391.85	2	0.32	28.31	3.29
903	6800	150	50.86	5391.59	3.18	0.25	27.63	2.95
902	6900	150	50.72	5391.35	2.18	0.25	28.62	2.96
901	7000	150	54.73	5391.15	2.32	0.21	28.86	2.74
90	7072	150	51.37	5390.93	2.53	0.31	44.98	3.13
89	7301	150	57.15	5390.42	2.62	0.2	38.07	2.68
88	7531	150	43.53	5389.86	2.96	0.33	23.74	3.48
87	7703	150	47.86	5389.44	2.54	0.28	24.98	3.13
86	7872	150	45.23	5388.94	2.54	0.33	32.03	3.36
85	8160	150	48.82	5388.11	3.01	0.29	50.02	3.18
84	8388	150	45.71	5387.41	2.81	0.33	29.36	3.28
83	8670	150	51.02	5386.68	2.48	0.25	28.96	2.96
82	8988	150	59.35	5386.09	3.79	0.19	33.67	2.53
81	9255	150	73.84	5385.65	2.65	0.16	97.06	2.33
80	9514	150	67.03	5385.22	2.62	0.18	64.72	2.49
79	9745	150	103.87	5384.93	3.43	0.15	142.93	2.34
78	9998	150	60.63	5384.57	3.17	0.18	62.66	2.57
77	10343	150	59.37	5384.02	2.22	0.19	44.59	2.57
76	10568	150	62.77	5383.65	2.75	0.18	57.59	2.54
75	10886	150	38.9	5382.68	1.88	0.46	25.88	3.86
74.8	10976	150	113.35	5382.65	2.79	0.11	132.57	2.03
74.7	11026	150	59.24	5382.55	3.25	0.18	27.78	2.53
74.5	Bridge							
74.3	11061	150	47.61	5382.39	2.19	0.3	31.75	3.15
74	11136	150	33.69	5381.89	2.19	0.6	20.73	4.45
73	11187	150	48.58	5381.77	2.07	0.3	37.21	3.1

Silver Bow Creek SSTOU, Reach A Proposed Channel Design, 230 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
976	-62	230	97.09	5415.51	3.01	0.2	52.01	2.77
975	0	230	79.98	5415.38	2.88	0.26	49.15	3.12
974.5	Bridge							
974	53	230	70.38	5415.07	2.77	0.29	37.52	3.33
973.5	Bridge							
973	123	230	62.62	5414.56	2.56	0.37	30.88	3.68
972	231	230	61.38	5414.21	2.51	0.39	32.07	3.75
971	333	230	59.82	5413.86	2.46	0.41	32.38	3.85
970.2	465	230	62.89	5413.44	2.54	0.38	35.09	3.69
970.19	633	230	61.42	5412.91	2.51	0.39	31.71	3.75
970.184	759	230	61.36	5412.51	2.51	0.39	34.17	3.76
970.183	791	230	61.23	5412.41	2.51	0.39	31.33	3.76
970.1821	830	230	61.01	5412.27	2.47	0.41	39.24	3.83
970.182	831	230	60.57	5412.27	2.47	0.41	37.09	3.84
970.181	891	230	59.88	5412.06	2.46	0.42	35.46	3.86
970.1809	892	230	59.56	5412.05	2.45	0.42	33.16	3.87
970.18	934	230	61.75	5411.92	2.52	0.38	31.64	3.73
961	1000	230	60.01	5411.71	2.48	0.41	40	3.86
960	1100	230	60.18	5411.37	2.48	0.41	41.96	3.86
959	1200	230	59.82	5411.03	2.48	0.42	41.74	3.87
958	1300	230	59.49	5410.68	2.47	0.42	42.15	3.89
957	1400	230	63.93	5410.36	3.59	0.37	48.49	3.64
956	1500	230	64.89	5410.04	3.61	0.37	51.73	3.6
955	1600	230	60.23	5409.67	2.48	0.41	44.88	3.86
954	1700	230	60.26	5409.33	2.48	0.41	45.98	3.86
953	1800	230	60.21	5408.99	2.48	0.41	45.5	3.86
952	1900	230	60.11	5408.65	2.48	0.41	44.43	3.86
951	2000	230	59.93	5408.31	2.48	0.42	44.49	3.87
950	2100	230	59.43	5407.95	2.46	0.42	41.87	3.9
949	2200	230	63.83	5407.63	3.58	0.38	48.16	3.64
948	2300	230	64.73	5407.31	3.6	0.37	51.88	3.61
947	2400	230	59.82	5406.94	2.47	0.42	43.46	3.88
946	2500	230	64.9	5406.63	3.6	0.37	54.82	3.61
945	2600	230	59.92	5406.27	2.48	0.42	44.16	3.87
944	2700	230	64.94	5405.96	3.61	0.37	52.76	3.6
943	2800	230	60.36	5405.59	2.48	0.41	46.48	3.86
942	2900	230	60	5405.26	2.49	0.41	37.82	3.86
941	3000	230	65.37	5404.95	3.62	0.36	46	3.57
940	3100	230	62.15	5404.61	2.52	0.39	51.82	3.78
939	3200	230	71.01	5404.35	3.7	0.33	74.78	3.43
938	3300	230	79.69	5404.11	3.8	0.29	94.29	3.23
937	3400	230	90.58	5403.92	2.85	0.26	120.14	3.16
936	3500	230	129.59	5403.81	4.18	0.17	169.87	2.56
935	3600	230	183.27	5403.75	4.46	0.11	206.55	2.1
934	3700	230	240.7	5403.72	3.67	0.08	231.27	1.81
933	3790	230	177.01	5403.67	3.96	0.08	316.75	1.91
932.75	3815	230	45.45	5403.25	3.62	0.6	274.96	5.15
932.6	Culvert							
932.25	3885	230	28.32	5401.72	2.26	1.79	28.75	8.12
932	3910	230	58.64	5401.82	2.45	0.43	31.68	3.93
931	4000	230	60.06	5401.51	2.48	0.42	44.46	3.87

930	4100	230	59.54	5401.16	2.47	0.42	36.21	3.88
929	4200	230	59.04	5400.81	2.46	0.43	35.16	3.91
928	4300	230	63.24	5400.48	3.57	0.38	43.68	3.66
927	4400	230	63.69	5400.15	3.58	0.38	47.6	3.65
926	4500	230	64.43	5399.83	3.6	0.37	51.17	3.62
925	4600	230	59.27	5399.45	2.46	0.42	41.13	3.9
924	4700	230	63.45	5399.13	3.58	0.38	46.9	3.66
923	4800	230	63.91	5398.8	3.59	0.38	48.53	3.64
922	4900	230	64.84	5398.47	3.6	0.37	52.51	3.6
921	5000	230	60.15	5398.11	2.48	0.41	45.48	3.86
920	5100	230	59.92	5397.77	2.48	0.42	44.18	3.87
919	5200	230	59.44	5397.42	2.47	0.42	41.42	3.9
918	5300	230	63.76	5397.1	3.59	0.38	43.1	3.64
917	5400	230	64.81	5396.77	3.6	0.37	52.33	3.6
916	5500	230	60.19	5396.41	2.48	0.42	47.65	3.87
915	5600	230	59.72	5396.06	2.47	0.42	43.03	3.88
914	5700	230	64.49	5395.75	3.6	0.37	50.81	3.62
913	5800	230	59.46	5395.38	2.47	0.42	42.28	3.9
912	5900	230	63.88	5395.05	3.58	0.38	49.23	3.64
911	6000	230	64.66	5394.73	3.6	0.37	50.17	3.61
910	6100	230	59.88	5394.37	2.48	0.42	43.77	3.88
909	6200	230	64.97	5394.06	3.61	0.37	53.27	3.6
908	6300	230	60.29	5393.69	2.48	0.41	45.73	3.86
907	6400	230	60.3	5393.35	2.48	0.41	45.92	3.86
906	6500	230	60.29	5393.01	2.48	0.41	45.63	3.86
905	6600	230	66.08	5392.71	3.62	0.36	57.43	3.56
904	6700	230	62.28	5392.37	2.52	0.39	54.06	3.78
903	6800	230	70.69	5392.11	3.7	0.33	72.08	3.43
902	6900	230	72.12	5391.84	2.67	0.33	82.89	3.51
901	7000	230	85.65	5391.64	2.81	0.28	110.95	3.24
90	7072	230	77.3	5391.46	3.06	0.32	54.8	3.36
89	7301	230	82.15	5391.02	3.22	0.24	45.77	3.08
88	7531	230	59.41	5390.39	3.49	0.46	41.94	4.23
87	7703	230	65	5389.93	3.03	0.39	68.93	3.79
86	7872	230	63.68	5389.38	2.98	0.44	55.62	4.01
85	8160	230	87.7	5388.6	3.5	0.34	94.87	3.56
84	8388	230	62.93	5387.92	3.32	0.39	39.05	3.75
83	8670	230	68.69	5387.2	3	0.33	41.96	3.56
82	8988	230	74.33	5386.52	4.22	0.27	37.12	3.09
81	9255	230	122.15	5386.07	3.07	0.18	126.69	2.58
80	9514	230	111.15	5385.64	3.04	0.22	161.39	2.88
79	9745	230	179.22	5385.4	3.9	0.15	180.33	2.42
78	9998	230	120.92	5385.05	3.65	0.21	164.95	2.88
77	10343	230	88.06	5384.47	2.67	0.25	79.16	3.04
76	10568	230	128.35	5384.11	3.21	0.21	230.85	2.85
75	10886	230	65.02	5383.19	2.39	0.5	79.33	4.22
74.8	10976	230	197.88	5383.23	3.37	0.1	155.11	2.04
74.7	11026	230	74.72	5383.08	3.78	0.25	32.82	3.09
74.5	Bridge							
74.3	11061	230	64.8	5382.91	2.71	0.36	35.11	3.55
74	11136	230	40.95	5382.23	2.53	0.9	21.66	5.62
73	11187	230	72.12	5382.18	2.48	0.37	69.45	3.57

Silver Bow Creek SSTOU, Reach A Proposed Channel Design, 440 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
976	-62	440	155.32	5416.48	3.98	0.3	66.85	3.6
975	0	440	130.85	5416.32	3.82	0.38	57.59	4.03
974.5	Bridge							
974	53	440	113.11	5416.04	3.74	0.44	47.26	4.32
973.5	Bridge							
973	123	440	93.83	5415.48	3.48	0.57	36.46	4.84
972	231	440	96.85	5415.13	3.43	0.58	42.53	4.86
971	333	440	97.1	5414.79	3.39	0.59	44.52	4.91
970.2	465	440	97.99	5414.37	3.47	0.56	40.99	4.79
970.19	633	440	98.48	5413.82	3.42	0.58	45.52	4.85
970.184	759	440	98.06	5413.4	3.4	0.58	45.44	4.88
970.183	791	440	95.77	5413.28	3.38	0.6	44.17	4.94
970.1821	830	440	100.05	5413.16	3.36	0.59	48.23	4.9
970.182	831	440	93.74	5413.13	3.33	0.62	39.88	5.01
970.181	891	440	92.97	5412.9	3.3	0.64	44.59	5.09
970.1809	892	440	96.47	5412.9	3.3	0.63	47.71	5.03
970.18	934	440	91.45	5412.73	3.33	0.64	42.21	5.07
961	1000	440	101.41	5412.52	3.29	0.63	55.01	5.04
960	1100	440	97.67	5412.1	3.21	0.68	54.09	5.2
959	1200	440	132.37	5411.77	3.22	0.59	134.52	4.85
958	1300	440	137.03	5411.42	3.21	0.58	148.75	4.82
957	1400	440	150.23	5411.13	4.36	0.49	157.22	4.38
956	1500	440	149	5410.84	4.41	0.47	136.62	4.3
955	1600	440	116.77	5410.41	3.22	0.61	84.27	4.94
954	1700	440	139.68	5410.08	3.23	0.57	150.83	4.77
953	1800	440	139.93	5409.73	3.22	0.57	152.51	4.77
952	1900	440	142.06	5409.39	3.22	0.57	161.04	4.77
951	2000	440	149.35	5409.07	3.24	0.55	174.24	4.68
950	2100	440	138.14	5408.7	3.21	0.58	152.69	4.82
949	2200	440	136.43	5408.37	4.32	0.53	138.34	4.56
948	2300	440	159.53	5408.09	4.38	0.46	168.71	4.27
947	2400	440	133.89	5407.68	3.21	0.59	141.94	4.85
946	2500	440	139.29	5407.37	4.34	0.52	139.21	4.5
945	2600	440	146.73	5407.01	3.22	0.56	173.25	4.73
944	2700	440	169.35	5406.75	4.4	0.45	203.97	4.22
943	2800	440	160.97	5406.46	3.35	0.48	167.66	4.39
942	2900	440	122.24	5406.05	3.28	0.59	107.16	4.87
941	3000	440	138.15	5405.79	4.46	0.47	112.47	4.35
940	3100	440	150.67	5405.54	3.45	0.45	111.15	4.27
939	3200	440	211.09	5405.42	4.77	0.28	159.45	3.39
938	3300	440	305.79	5405.35	5.04	0.17	236.89	2.71
937	3400	440	428.51	5405.31	4.24	0.12	322.65	2.26
936	3500	440	450.7	5405.28	5.65	0.08	242.79	1.89
935	3600	440	559.21	5405.25	5.96	0.06	310.59	1.63
934	3700	440	731.79	5405.24	5.19	0.04	407.14	1.41
933	3790	440	369.97	5405.2	5.49	0.08	400.77	1.93
932.75	3815	440	77.79	5404.49	4.86	0.95	395.78	6.79
932.6	Culvert							
932.25	3885	440	53.2	5403.09	3.63	1.94	267.12	9.2
932	3910	440	32.78	5400.91	1.54	5.94	27.52	13.42
931	4000	440	170.1	5402.38	3.35	0.46	189.24	4.33

930	4100	440	118.94	5401.96	3.27	0.61	108.82	4.95
929	4200	440	112.82	5401.55	3.2	0.65	97.31	5.09
928	4300	440	123.72	5401.21	4.3	0.58	123.15	4.75
927	4400	440	147.08	5400.89	4.32	0.51	162.97	4.48
926	4500	440	153.94	5400.58	4.35	0.48	167.21	4.36
925	4600	440	141.37	5400.18	3.19	0.6	178.95	4.87
924	4700	440	150.29	5399.87	4.32	0.51	175.97	4.47
923	4800	440	152.23	5399.53	4.32	0.51	190.58	4.48
922	4900	440	162.33	5399.24	4.37	0.47	191.19	4.3
921	5000	440	140.95	5398.86	3.23	0.56	151.34	4.74
920	5100	440	148.49	5398.54	3.25	0.54	167.35	4.66
919	5200	440	144.9	5398.21	3.26	0.55	158.03	4.68
918	5300	440	126.22	5397.85	4.34	0.55	122.28	4.66
917	5400	440	156.62	5397.58	4.41	0.46	159.31	4.25
916	5500	440	122.69	5397.14	3.21	0.62	123.47	4.98
915	5600	440	144.01	5396.79	3.2	0.59	187.11	4.83
914	5700	440	157.16	5396.5	4.35	0.49	195.66	4.4
913	5800	440	142.09	5396.1	3.19	0.59	170.76	4.83
912	5900	440	149.65	5395.8	4.33	0.49	153.57	4.4
911	6000	440	153.08	5395.49	4.36	0.49	175.55	4.4
910	6100	440	144.15	5395.1	3.21	0.59	187.09	4.83
909	6200	440	162.49	5394.81	4.36	0.48	204.92	4.34
908	6300	440	149.16	5394.44	3.23	0.56	186.34	4.73
907	6400	440	149.94	5394.1	3.23	0.56	195.49	4.74
906	6500	440	148.98	5393.76	3.23	0.55	178.51	4.7
905	6600	440	135.15	5393.44	4.35	0.52	133.21	4.54
904	6700	440	159.72	5393.12	3.27	0.52	203.74	4.58
903	6800	440	196.13	5392.92	4.51	0.38	237.25	3.91
902	6900	440	227.86	5392.74	3.57	0.34	263.8	3.73
901	7000	440	276.56	5392.63	3.8	0.23	249.02	3.13
90	7072	440	153.5	5392.4	4	0.39	161.23	3.99
89	7301	440	149.28	5391.93	4.13	0.38	125.27	4.05
88	7531	440	124.11	5391.2	4.3	0.69	119.13	5.43
87	7703	440	147.65	5390.78	3.88	0.48	104.97	4.46
86	7872	440	114.05	5390.12	3.72	0.67	86.05	5.23
85	8160	440	191.72	5389.54	4.44	0.35	123.26	3.81
84	8388	440	106.01	5388.83	4.23	0.55	54.05	4.76
83	8670	440	134.15	5388.07	3.87	0.5	152.99	4.61
82	8988	440	105.02	5387.18	4.88	0.5	54.71	4.4
81	9255	440	237.7	5386.72	3.72	0.26	239.6	3.24
80	9514	440	269.3	5386.34	3.74	0.25	274.08	3.2
79	9745	440	339.5	5386.12	4.62	0.18	268.43	2.76
78	9998	440	280.78	5385.81	4.41	0.24	258.12	3.18
77	10343	440	150.37	5385.08	3.28	0.43	138.82	4.17
76	10568	440	319.85	5384.84	3.94	0.2	285.75	2.89
75	10886	440	234.82	5384.41	3.61	0.27	159.28	3.35
74.8	10976	440	402.4	5384.4	4.54	0.1	199.84	2.07
74.7	11026	440	120.95	5384.14	4.84	0.37	48.82	4.02
74.5	Bridge							
74.3	11061	440	112.05	5384	3.8	0.43	48.34	4.2
74	11136	440	54.28	5382.76	3.06	1.86	30.05	8.35
73	11187	440	127.52	5382.89	3.19	0.51	87.14	4.46

Silver Bow Creek SSTOU, Reach A Proposed Channel Design, 610 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
976	-62	610	196.92	5417.08	4.58	0.37	72.03	4.11
975	0	610	165	5416.9	4.4	0.47	60.02	4.59
974.5	Bridge							
974	53	610	142.59	5416.65	4.35	0.54	49.87	4.92
973.5	Bridge							
973	123	610	115.93	5416.06	4.06	0.71	39.47	5.57
972	231	610	122.57	5415.71	4.01	0.7	45.55	5.52
971	333	610	124.3	5415.38	3.98	0.71	47.54	5.53
970.2	465	610	122.64	5414.94	4.04	0.69	44.63	5.49
970.19	633	610	126	5414.39	3.99	0.7	49.9	5.5
970.184	759	610	125.09	5413.97	3.97	0.71	49.81	5.54
970.183	791	610	121.42	5413.83	3.93	0.74	49.1	5.64
970.1821	830	610	127.87	5413.72	3.92	0.71	51.57	5.53
970.182	831	610	115.02	5413.65	3.85	0.79	42.96	5.81
970.181	891	610	116.01	5413.4	3.8	0.81	46.56	5.87
970.1809	892	610	121.77	5413.41	3.81	0.78	50.71	5.75
970.18	934	610	112.14	5413.19	3.79	0.84	46.52	5.96
961	1000	610	127.79	5412.98	3.75	0.79	58.74	5.8
960	1100	610	115.15	5412.42	3.53	0.96	55.9	6.31
959	1200	610	183.12	5412.14	3.59	0.68	137.57	5.32
958	1300	610	199.8	5411.82	3.61	0.63	159.54	5.13
957	1400	610	225.38	5411.57	4.8	0.5	176.37	4.56
956	1500	610	212.61	5411.3	4.87	0.49	140.3	4.53
955	1600	610	146.04	5410.75	3.56	0.8	87	5.76
954	1700	610	202.65	5410.45	3.6	0.64	175.86	5.17
953	1800	610	201.66	5410.09	3.58	0.66	190.13	5.25
952	1900	610	206.88	5409.75	3.58	0.65	198.7	5.21
951	2000	610	222.82	5409.44	3.61	0.6	210.75	5
950	2100	610	202.35	5409.09	3.6	0.63	165.83	5.13
949	2200	610	192.84	5408.73	4.68	0.63	172.75	5.09
948	2300	610	225.87	5408.48	4.77	0.5	171.82	4.55
947	2400	610	193.57	5408.06	3.59	0.67	165.37	5.28
946	2500	610	194.18	5407.72	4.69	0.63	175.27	5.07
945	2600	610	226.03	5407.43	3.64	0.57	194.47	4.87
944	2700	610	282.41	5407.25	4.9	0.4	239.83	4.07
943	2800	610	273.71	5407.03	3.92	0.42	227.69	4.25
942	2900	610	193.01	5406.7	3.93	0.53	111.12	4.79
941	3000	610	225.41	5406.55	5.22	0.39	117.69	4.08
940	3100	610	250.43	5406.41	4.32	0.34	118.15	3.87
939	3200	610	366.04	5406.37	5.72	0.18	167.04	2.87
938	3300	610	546.07	5406.35	6.04	0.1	244.85	2.15
937	3400	610	763.54	5406.33	5.26	0.06	330.82	1.72
936	3500	610	757.21	5406.31	6.68	0.06	350.26	1.71
935	3600	610	939.95	5406.3	7.01	0.04	410.75	1.42
934	3700	610	1164.79	5406.29	6.24	0.03	416.62	1.17
933	3790	610	502.66	5406.25	6.54	0.07	409.15	1.97
932.75	3815	610	102.43	5405.43	5.8	1.08	403.3	7.44
932.6	Culvert							
932.25	3885	610	72.74	5403.82	4.36	2.16	377.7	10.03
932	3910	610	41.18	5401.21	1.84	6.77	28.04	14.81
931	4000	610	270.97	5402.86	3.83	0.45	238.02	4.36

930	4100	610	166.39	5402.39	3.7	0.69	110.56	5.41
929	4200	610	148.34	5401.92	3.57	0.81	98.75	5.8
928	4300	610	169.55	5401.55	4.64	0.71	135.42	5.36
927	4400	610	210.86	5401.25	4.68	0.58	185.78	4.87
926	4500	610	216.24	5400.92	4.69	0.57	203.18	4.85
925	4600	610	211.63	5400.53	3.54	0.66	215.84	5.24
924	4700	610	218.64	5400.22	4.67	0.58	211.76	4.87
923	4800	610	235.69	5399.91	4.7	0.56	252.26	4.78
922	4900	610	247.1	5399.64	4.77	0.49	230.15	4.5
921	5000	610	205.47	5399.24	3.61	0.64	189.62	5.17
920	5100	610	224.88	5398.94	3.65	0.58	210.54	4.94
919	5200	610	225.1	5398.65	3.7	0.57	204.95	4.89
918	5300	610	181.66	5398.24	4.73	0.66	163.02	5.21
917	5400	610	233.53	5398.01	4.84	0.5	204.47	4.53
916	5500	610	168.71	5397.47	3.54	0.79	157.49	5.73
915	5600	610	221.45	5397.14	3.55	0.66	255.89	5.25
914	5700	610	238.4	5396.87	4.72	0.54	242	4.69
913	5800	610	210.47	5396.46	3.55	0.66	208.74	5.22
912	5900	610	202.93	5396.15	4.68	0.58	155.97	4.86
911	6000	610	218.25	5395.84	4.71	0.55	188.1	4.76
910	6100	610	220.81	5395.44	3.55	0.67	255.15	5.25
909	6200	610	244.92	5395.16	4.71	0.54	274.03	4.72
908	6300	610	221.09	5394.79	3.58	0.62	222.29	5.1
907	6400	610	237.4	5394.48	3.61	0.59	252.26	4.97
906	6500	610	233.01	5394.18	3.65	0.57	221.68	4.87
905	6600	610	185.96	5393.78	4.69	0.66	168.44	5.18
904	6700	610	248.06	5393.52	3.67	0.54	244.65	4.75
903	6800	610	315.45	5393.34	4.93	0.38	323.86	4
902	6900	610	370.09	5393.21	4.04	0.29	308.81	3.58
901	7000	610	408.42	5393.12	4.29	0.22	277.99	3.13
90	7072	610	238.08	5392.89	4.49	0.41	175.72	4.2
89	7301	610	214.54	5392.34	4.54	0.49	169.87	4.68
88	7531	610	200.48	5391.69	4.79	0.71	164.25	5.64
87	7703	610	202.33	5391.28	4.38	0.53	114.8	4.79
86	7872	610	162.4	5390.59	4.19	0.78	118.47	5.78
85	8160	610	264.42	5390.1	5	0.37	139.48	4.03
84	8388	610	129.57	5389.25	4.65	0.74	59.4	5.64
83	8670	610	255.7	5388.6	4.4	0.5	311.96	4.73
82	8988	610	123.66	5387.48	5.18	0.73	77.73	5.42
81	9255	610	332.6	5387.08	4.08	0.28	283.55	3.43
80	9514	610	382.6	5386.74	4.14	0.25	292.53	3.29
79	9745	610	456.99	5386.53	5.03	0.2	301.92	2.98
78	9998	610	399.66	5386.23	4.83	0.26	318.4	3.36
77	10343	610	223.6	5385.48	3.68	0.5	214.81	4.58
76	10568	610	460.14	5385.31	4.41	0.18	301.2	2.84
75	10886	610	325.39	5384.94	4.14	0.28	182.33	3.49
74.8	10976	610	513.58	5384.92	5.06	0.11	233.88	2.32
74.7	11026	610	140.41	5384.54	5.24	0.54	48.83	4.92
74.5	Bridge							
74.3	11061	610	129.07	5384.35	4.15	0.62	48.82	5.14
74	11136	610	163.19	5383.87	4.17	1.02	189.34	6.61
73	11187	610	204.07	5383.27	3.57	0.59	254.89	4.9

Silver Bow Creek SSTOU, Reach A Proposed Channel Design, 780 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
976	-62	780	235.23	5417.6	5.1	0.43	77.13	4.54
975	0	780	195.17	5417.39	4.89	0.55	62.09	5.06
974.5	Bridge							
974	53	780	168.57	5417.16	4.86	0.64	52.06	5.45
973.5	Bridge							
973	123	780	136.41	5416.56	4.56	0.84	42.06	6.19
972	231	780	146.29	5416.22	4.52	0.81	48.16	6.07
971	333	780	149.15	5415.88	4.48	0.81	50.14	6.05
970.2	465	780	144.87	5415.42	4.52	0.82	47.64	6.09
970.19	633	780	164.06	5414.89	4.49	0.79	104.03	5.97
970.184	759	780	163.38	5414.47	4.47	0.79	103.28	5.99
970.183	791	780	151.09	5414.32	4.42	0.84	84.27	6.16
970.1821	830	780	153.89	5414.21	4.41	0.81	54.24	6.04
970.182	831	780	134.66	5414.09	4.29	0.95	45.46	6.49
970.181	891	780	136.75	5413.84	4.24	0.96	47.92	6.52
970.1809	892	780	145.35	5413.87	4.27	0.9	53.28	6.33
970.18	934	780	131.18	5413.59	4.19	1.02	49.33	6.7
961	1000	780	152.75	5413.4	4.17	0.93	62.07	6.4
960	1100	780	128.64	5412.65	3.76	1.28	57.26	7.36
959	1200	780	227.33	5412.46	3.91	0.75	140.17	5.69
958	1300	780	256.22	5412.17	3.96	0.66	162.35	5.32
957	1400	780	293.93	5411.95	5.18	0.5	179.46	4.63
956	1500	780	267.05	5411.68	5.25	0.52	143.37	4.75
955	1600	780	168.31	5411	3.81	1.01	89.02	6.56
954	1700	780	255.97	5410.75	3.9	0.69	178.67	5.46
953	1800	780	258.3	5410.37	3.86	0.75	219.04	5.65
952	1900	780	267.81	5410.04	3.87	0.7	215.21	5.49
951	2000	780	291.26	5409.77	3.94	0.61	213.32	5.11
950	2100	780	252.18	5409.39	3.9	0.69	168.2	5.45
949	2200	780	246.96	5409.04	4.99	0.68	175.25	5.36
948	2300	780	280.47	5408.79	5.08	0.54	174.35	4.81
947	2400	780	253.03	5408.41	3.94	0.68	168.23	5.42
946	2500	780	276.45	5408.14	5.11	0.59	205.3	5.03
945	2600	780	330.95	5407.97	4.18	0.45	198.74	4.45
944	2700	780	432.2	5407.87	5.52	0.28	244.8	3.51
943	2800	780	458	5407.76	4.65	0.27	260.21	3.5
942	2900	780	295.79	5407.46	4.69	0.47	177.72	4.67
941	3000	780	348.65	5407.38	6.05	0.31	161.02	3.78
940	3100	780	358.29	5407.3	5.21	0.26	125.27	3.55
939	3200	780	521.64	5407.28	6.63	0.14	174.32	2.59
938	3300	780	776.05	5407.27	6.96	0.07	252.23	1.9
937	3400	780	1075.53	5407.27	6.2	0.04	338.24	1.51
936	3500	780	1120.13	5407.25	7.62	0.04	398.11	1.5
935	3600	780	1332.84	5407.25	7.96	0.03	419.62	1.25
934	3700	780	1563.48	5407.24	7.19	0.02	425.16	1.08
933	3790	780	622.11	5407.2	7.49	0.07	416.71	2.02
932.75	3815	780	124.97	5406.3	6.67	1.17	410.19	7.93
932.6	Culvert							
932.25	3885	780	87.5	5404.37	4.91	2.47	423.51	10.95
932	3910	780	49.28	5401.5	2.13	7.34	28.53	15.83
931	4000	780	373.32	5403.25	4.22	0.43	278.93	4.34

930	4100	780	206.38	5402.75	4.06	0.77	112	5.79
929	4200	780	176.37	5402.2	3.85	0.97	99.88	6.45
928	4300	780	206.68	5401.82	4.91	0.82	137.59	5.87
927	4400	780	264.53	5401.53	4.96	0.64	188.1	5.17
926	4500	780	274.89	5401.19	4.96	0.65	231.99	5.23
925	4600	780	276.55	5400.81	3.82	0.72	245.04	5.52
924	4700	780	279.98	5400.49	4.94	0.64	239.37	5.2
923	4800	780	315.99	5400.21	5	0.57	282.58	4.91
922	4900	780	321.8	5399.96	5.09	0.49	232.73	4.59
921	5000	780	268.26	5399.55	3.92	0.7	220.58	5.48
920	5100	780	298.51	5399.27	3.98	0.61	245.06	5.14
919	5200	780	301.36	5398.99	4.04	0.59	241.24	5.07
918	5300	780	237.63	5398.55	5.04	0.74	195.73	5.61
917	5400	780	307.66	5398.34	5.17	0.53	240.09	4.76
916	5500	780	209.45	5397.71	3.78	0.96	182.37	6.39
915	5600	780	300.89	5397.42	3.83	0.71	311.02	5.49
914	5700	780	315.01	5397.17	5.02	0.55	257.15	4.81
913	5800	780	277.08	5396.76	3.85	0.7	240.02	5.47
912	5900	780	244.76	5396.42	4.95	0.67	157.83	5.3
911	6000	780	266.7	5396.1	4.97	0.63	189.89	5.15
910	6100	780	297.16	5395.71	3.82	0.72	308.36	5.54
909	6200	780	332.26	5395.45	5	0.56	318.02	4.86
908	6300	780	286.91	5395.07	3.86	0.68	250.72	5.38
907	6400	780	322.03	5394.79	3.92	0.59	285.14	5.05
906	6500	780	311.9	5394.52	3.99	0.58	255.66	5.01
905	6600	780	235.16	5394.04	4.95	0.77	196.63	5.68
904	6700	780	328.09	5393.82	3.97	0.56	276.53	4.91
903	6800	780	433.38	5393.69	5.28	0.35	337.75	3.88
902	6900	780	484.32	5393.58	4.41	0.28	311.75	3.52
901	7000	780	512	5393.5	4.67	0.22	280.95	3.2
90	7072	780	300.83	5393.24	4.84	0.47	186.98	4.53
89	7301	780	272.56	5392.68	4.88	0.55	175.56	5.03
88	7531	780	269.35	5392.09	5.19	0.72	178.94	5.75
87	7703	780	248.18	5391.66	4.76	0.6	126.57	5.17
86	7872	780	215.02	5390.99	4.59	0.84	138.74	6.09
85	8160	780	339.08	5390.54	5.44	0.39	228.8	4.22
84	8388	780	143.37	5389.46	4.86	1.02	69.52	6.67
83	8670	780	395.14	5389.02	4.82	0.44	354.75	4.51
82	8988	780	145.86	5387.71	5.41	0.98	122.5	6.36
81	9255	780	429.14	5387.38	4.38	0.3	365.63	3.59
80	9514	780	475.51	5387.05	4.45	0.27	306.63	3.44
79	9745	780	553.45	5386.84	5.34	0.22	323.43	3.18
78	9998	780	503.89	5386.55	5.15	0.26	330.11	3.45
77	10343	780	308.44	5385.86	4.06	0.5	235.04	4.68
76	10568	780	584.24	5385.72	4.82	0.18	314.23	2.86
75	10886	780	406.67	5385.36	4.56	0.29	200.78	3.64
74.8	10976	780	627.88	5385.34	5.48	0.14	313.05	2.58
74.7	11026	780	153.43	5384.81	5.51	0.74	48.84	5.83
74.5	Bridge							
74.3	11061	780	137.67	5384.53	4.33	0.89	48.82	6.21
74	11136	780	209.01	5384.1	4.4	1.21	206.61	7.26
73	11187	780	273.61	5383.53	3.83	0.65	267.76	5.19

Silver Bow Creek SSTOU, Reach A Proposed Channel Design, 1042 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
976	-62	1042	292.74	5418.31	5.81	0.51	84.21	5.05
975	0	1042	238.62	5418.08	5.58	0.65	64.95	5.67
974.5	Bridge							
974	53	1042	204.73	5417.83	5.53	0.78	54.96	6.16
973.5	Bridge							
973	123	1042	164.98	5417.22	5.22	1.03	45.43	7.03
972	231	1042	178.91	5416.88	5.18	0.98	51.55	6.83
971	333	1042	182.53	5416.53	5.13	0.97	53.43	6.8
970.2	465	1042	173	5415.99	5.09	1.04	51.17	7.01
970.19	633	1042	263.22	5415.59	5.19	0.81	180.79	6.22
970.184	759	1042	280.97	5415.27	5.27	0.75	191.31	6
970.183	791	1042	253	5415.12	5.22	0.82	171.96	6.28
970.1821	830	1042	192.38	5414.9	5.1	0.94	57.74	6.66
970.182	831	1042	163.34	5414.7	4.9	1.16	48.57	7.36
970.181	891	1042	166.36	5414.44	4.84	1.16	49.81	7.35
970.1809	892	1042	179.96	5414.5	4.9	1.06	56.85	7.05
970.18	934	1042	160.2	5414.15	4.75	1.25	53.32	7.59
961	1000	1042	191.68	5414	4.77	1.08	66.94	7.07
960	1100	1042	144.42	5412.93	4.04	1.83	58.8	8.92
959	1200	1042	290.49	5412.91	4.36	0.83	143.8	6.09
958	1300	1042	335.72	5412.65	4.44	0.68	166.23	5.54
957	1400	1042	387.44	5412.47	5.7	0.51	183.6	4.77
956	1500	1042	341.32	5412.19	5.76	0.56	147.47	5.05
955	1600	1042	194.51	5411.29	4.1	1.37	91.35	7.74
954	1700	1042	316.78	5411.09	4.24	0.82	181.82	6.02
953	1800	1042	343.6	5410.75	4.24	0.79	225.02	5.92
952	1900	1042	358.68	5410.46	4.29	0.72	218.59	5.64
951	2000	1042	388.31	5410.22	4.39	0.61	216.91	5.21
950	2100	1042	332.4	5409.86	4.37	0.71	171.97	5.65
949	2200	1042	344	5409.59	5.54	0.64	179.64	5.32
948	2300	1042	387.41	5409.4	5.69	0.5	179.19	4.73
947	2400	1042	383.07	5409.17	4.7	0.53	174.32	4.93
946	2500	1042	468.79	5409.06	6.03	0.37	212.64	4.12
945	2600	1042	535.61	5408.98	5.19	0.28	206.82	3.68
944	2700	1042	697.59	5408.94	6.59	0.17	253.37	2.86
943	2800	1042	756.96	5408.89	5.78	0.16	269.21	2.78
942	2900	1042	553.31	5408.76	5.99	0.26	204.71	3.59
941	3000	1042	569.7	5408.71	7.38	0.2	172.47	3.17
940	3100	1042	534.6	5408.65	6.56	0.2	136.11	3.25
939	3200	1042	766.89	5408.65	8	0.11	185.22	2.35
938	3300	1042	1129.51	5408.65	8.34	0.06	263.18	1.71
937	3400	1042	1548.65	5408.64	7.57	0.03	349.21	1.35
936	3500	1042	1680.11	5408.64	9.01	0.03	411.52	1.28
935	3600	1042	1923.53	5408.63	9.34	0.02	432.61	1.11
934	3700	1042	2162.15	5408.63	8.58	0.02	437.67	1
933	3790	1042	797.04	5408.58	8.87	0.07	427.76	2.08
932.75	3815	1042	159.01	5407.6	7.97	1.24	420.59	8.42
932.6	Culvert							
932.25	3885	1042	108.39	5405.16	5.7	2.85	437.65	12.05
932	3910	1042	61.48	5401.9	2.53	8.02	36.23	17.07
931	4000	1042	527.88	5403.78	4.75	0.38	297.16	4.21

930	4100	1042	259.38	5403.22	4.53	0.88	113.88	6.31
929	4200	1042	212.22	5402.55	4.2	1.22	101.3	7.35
928	4300	1042	253.96	5402.16	5.25	1	140.31	6.58
927	4400	1042	328.74	5401.87	5.3	0.74	190.82	5.67
926	4500	1042	357.82	5401.52	5.29	0.74	255.43	5.66
925	4600	1042	369.99	5401.17	4.18	0.78	275.35	5.85
924	4700	1042	367.19	5400.83	5.28	0.73	273.86	5.63
923	4800	1042	427.11	5400.59	5.38	0.58	294.39	5.02
922	4900	1042	409.64	5400.34	5.47	0.54	235.73	4.88
921	5000	1042	356.93	5399.92	4.29	0.77	247.24	5.84
920	5100	1042	401.18	5399.66	4.37	0.63	261.48	5.33
919	5200	1042	410.14	5399.41	4.46	0.61	265.31	5.23
918	5300	1042	320.12	5398.93	5.42	0.85	235.8	6.09
917	5400	1042	412.67	5398.77	5.6	0.54	249.27	4.91
916	5500	1042	259.92	5397.96	4.03	1.25	209.14	7.38
915	5600	1042	427.97	5397.8	4.21	0.69	347.3	5.51
914	5700	1042	412.68	5397.55	5.4	0.57	260.39	5
913	5800	1042	387.94	5397.18	4.27	0.7	276.64	5.59
912	5900	1042	297.19	5396.75	5.28	0.82	162.55	5.96
911	6000	1042	323.75	5396.4	5.27	0.77	191.97	5.77
910	6100	1042	418.77	5396.07	4.18	0.75	371.7	5.74
909	6200	1042	461.84	5395.83	5.38	0.56	357.27	4.94
908	6300	1042	384.98	5395.43	4.22	0.75	294.76	5.75
907	6400	1042	444.56	5395.19	4.32	0.6	326.93	5.17
906	6500	1042	424.69	5394.92	4.39	0.61	297.57	5.23
905	6600	1042	316.13	5394.42	5.33	0.87	235.79	6.16
904	6700	1042	456.96	5394.26	4.41	0.55	321.28	4.99
903	6800	1042	590.75	5394.16	5.75	0.32	341.45	3.79
902	6900	1042	633.03	5394.06	4.89	0.27	315.53	3.56
901	7000	1042	646.38	5393.97	5.14	0.24	284.75	3.35
90	7072	1042	393.04	5393.69	5.29	0.53	218.57	4.92
89	7301	1042	356.39	5393.12	5.32	0.62	198.81	5.44
88	7531	1042	365.94	5392.61	5.71	0.72	190.15	5.87
87	7703	1042	310.65	5392.13	5.23	0.7	146.45	5.73
86	7872	1042	288.22	5391.49	5.09	0.9	153.48	6.45
85	8160	1042	516.59	5391.14	6.04	0.37	330.77	4.23
84	8388	1042	161.07	5389.69	5.09	1.52	83.1	8.23
83	8670	1042	588.75	5389.54	5.34	0.39	390.25	4.33
82	8988	1042	181.38	5387.95	5.65	1.39	180.81	7.69
81	9255	1042	582.35	5387.8	4.8	0.31	377.88	3.7
80	9514	1042	610.27	5387.48	4.88	0.29	332.32	3.65
79	9745	1042	698.48	5387.26	5.76	0.25	355.49	3.4
78	9998	1042	654.95	5386.99	5.59	0.27	348.37	3.56
77	10343	1042	475.87	5386.43	4.63	0.44	329.47	4.51
76	10568	1042	778.04	5386.31	5.41	0.17	340.37	2.87
75	10886	1042	544.13	5385.99	5.19	0.31	257.46	3.82
74.8	10976	1042	859.52	5385.98	6.12	0.14	402.12	2.66
74.7	11026	1042	172.79	5385.2	5.9	1.04	48.85	7.02
74.5	Bridge							
74.3	11061	1042	145.42	5384.69	4.49	1.42	48.83	7.89
74	11136	1042	292.91	5384.49	4.79	1.26	228.07	7.54
73	11187	1042	366.15	5383.87	4.17	0.71	283.98	5.55

Silver Bow Creek SSTOU, Reach A Proposed Channel Design, 2330 cfs

HEC XS	Station	Q Total (cfs)	Flow Area (sq ft)	W.S. Elev (ft)	Depth (ft)	Shear Chan (lb/sq ft)	Top Width (ft)	Vel Chan (ft/s)
976	-62	2330	591.8	5421.24	8.74	0.71	121.4	6.38
975	0	2330	437.85	5420.89	8.39	0.97	76.72	7.4
974.5	Bridge							
974	53	2330	363.09	5420.45	8.15	1.26	66.19	8.41
973.5	Bridge							
973	123	2330	277.97	5419.43	7.43	1.9	56.82	10.17
972	231	2330	305.02	5419.08	7.38	1.74	62.94	9.72
971	333	2330	306.77	5418.64	7.24	1.77	64.23	9.78
970.2	465	2330	334.9	5417.95	7.05	1.91	159.86	10.09
970.19	633	2330	1227.29	5418.52	8.12	0.37	438.29	4.56
970.184	759	2330	1382.75	5418.46	8.46	0.29	446.44	4.04
970.183	791	2330	1365.4	5418.43	8.53	0.29	443.88	4.09
970.1821	830	2330	377.32	5417.46	7.66	1.37	91.18	8.69
970.182	831	2330	292.5	5416.89	7.09	2.01	73	10.35
970.181	891	2330	290.97	5416.59	6.99	2.01	71.05	10.34
970.1809	892	2330	335.84	5416.81	7.21	1.65	81.4	9.42
970.18	934	2330	285.41	5416.2	6.8	2.13	74.87	10.59
961	1000	2330	363.35	5416.26	7.03	1.59	84.74	9.18
960	1100	2330	254.95	5414.66	5.77	3.01	68.66	12.21
959	1200	2330	563.05	5414.7	6.15	1.03	160.87	7.24
958	1300	2330	665.66	5414.55	6.34	0.77	181.45	6.28
957	1400	2330	762.54	5414.43	7.66	0.57	199.35	5.4
956	1500	2330	642.71	5414.13	7.7	0.73	163.03	6.1
955	1600	2330	319.99	5412.59	5.4	2.55	101.73	11.12
954	1700	2330	661.19	5412.9	6.05	0.84	198.73	6.51
953	1800	2330	817.3	5412.78	6.27	0.59	241.28	5.51
952	1900	2330	857.44	5412.66	6.49	0.52	235.6	5.18
951	2000	2330	914.91	5412.54	6.71	0.44	235.98	4.82
950	2100	2330	783.22	5412.33	6.84	0.56	197.89	5.44
949	2200	2330	848.03	5412.23	8.18	0.45	201.13	4.85
948	2300	2330	911.51	5412.15	8.44	0.38	201.23	4.48
947	2400	2330	919.7	5412.06	7.59	0.38	197.48	4.57
946	2500	2330	1136.04	5412.04	9.01	0.25	236.35	3.71
945	2600	2330	1195.24	5411.99	8.2	0.23	230.94	3.59
944	2700	2330	1505.43	5411.98	9.63	0.14	277.84	2.84
943	2800	2330	1620.2	5411.95	8.84	0.13	293.64	2.75
942	2900	2330	1253.84	5411.87	9.1	0.22	256.12	3.56
941	3000	2330	1155.93	5411.82	10.49	0.22	220.61	3.59
940	3100	2330	1008.47	5411.73	9.64	0.28	179.83	4.11
939	3200	2330	1379.7	5411.75	11.1	0.15	210	2.94
938	3300	2330	2047.09	5411.76	11.45	0.08	315.81	2.13
937	3400	2330	2724.75	5411.76	10.69	0.05	409.13	1.7
936	3500	2330	3028.61	5411.75	12.12	0.04	448.9	1.52
935	3600	2330	3345.81	5411.75	12.46	0.03	471.39	1.37
934	3700	2330	3603.33	5411.75	11.7	0.03	497.46	1.32
933	3790	2330	2960.38	5411.74	12.03	0.03	457.33	1.44
932.75	3815	2330	2779.27	5411.73	12.1	0.04	458.47	1.52
932.6	Culvert							
932.25	3885	2330	185.43	5408.04	8.58	4.4	489.82	16.07
932	3910	2330	143.79	5402.9	3.53	13.09	244.72	23.26
931	4000	2330	1117.3	5405.71	6.68	0.34	312.65	4.23

APPENDIX H-2

County Road Crossings

Memorandum

To: SSTOU, Subarea 1, Reach A Design
From: Dale White
Date: April 7, 1998
Regarding: Culverts at county road crossing: discussion of comments.

Hec-Ras modeling

The culverts have been integrated into both the final conditions models for the reconstructed channel and the diversion channel. Output, including expected water surface elevations and velocities in the culverts and backwater areas, can be found in Appendix H-2. Main text Table 3.9-1 summarizes expected backwater elevations for the 5-, 10-, 20-, 50-, and 100-yr flows.

Hec-Ras input for the culverts included the following.

Culvert	Inlet invert elevation	Outlet invert elevation	Manning's "n"	Entrance loss coeff.	Exit loss coeff.
Channel	5399.7	5399.4	0.028	0.5	1.0
Floodplain	5402.3	5402.0	0.028	0.5	1.0

Both culverts were 70 ft long with a slope of 0.004. Placing the culverts at this slope, which is slightly steeper than the local reconstructed channel bed slope of 0.0034, will lower the possibility of sediment deposition occurring within the culvert barrel.

H-20 loading

The minimum cover depth of 2 ft was determined using standard design tables. The embankment was also designed for H-20 loading (see embankment design technical memo).

Riprap basin

The riprap basin design was based on methodology presented in USDOT, FHWA HEC-14 (*Hydraulic Design of Energy Dissipators for Culverts and Channels*). The following steps were completed:

1. Hec-Ras output was examined for the 2-100 year discharges (see attached). The 10-yr discharge had the highest outlet velocity (10.15 fps). This discharge was used for subsequent calculations.
2. Cross-sectional area of flow (A) was determined to be 48 sq ft.
3. y_o was calculated: $y_o = (A/2)^{0.5} = 4.9$
4. Froude number F_r was calculated: $F_r = V/(g*d)^{0.5} = 0.81$
   (where V = 10.15 and g = 32.2)
5. Assume $D_{50}/ y_o = 0.1$, then $D_{50} = 0.5$ ft
6. Using Figure X1-2 (attached), $h_o / y_o = 0.5$, thus $h_o = 2.5$ ft
7. Pool length = $10h_o = 25$ ft
8. Apron length = $5h_o = 12$ ft
9. Riprap thickness = $2 D_{50} = 1$ ft
10. Equivalent diameter (D_e): $D_e^2 (pi)/4 = 48$, $D_e = 7.8$ ft
11. Use Figure XI-15 to determine distance downstream (L) the velocity will drop to 6.5 fps (6.5 fps is approximate average velocity for diversion channel below culvert). $L/ D_e = 9$, thus L = 70 ft
12. Since the computed L does not take into account the roughness of channel banks, use L = 65 ft in design
13. Figure X1-1 was used to determine dimensions of riprap basin

Silver Bow Creek SSTOU, Subarea 1, Reach A Design

D. White 4/8/98

Plan: Plan 05 River: Silver Bow Reach:a Riv Sta: 932.6 Profile: 5 yr Culvert ID: Culvert #1 Culv: Culvert #1

Culv Q (cfs)	323.40	Culv Vel In (ft/s)	7.06
# Barrels	1	Culv Vel Out (ft/s)	7.28
Q Barrel (cfs)	323.40	Culv Inv El Up (ft)	5399.70
W.S. US. (ft)	5404.49	Culv Inv El Dn (ft)	5399.40
E.G. US. (ft)	5405.17	Culv Frctn Ls (ft)	0.39
Delta WS (ft)	1.40	Culv Ext Lss (ft)	0.02
Delta EG (ft)	0.79	Culv Ent Lss (ft)	0.39
E.G. IC (ft)	5404.75	Q Weir (cfs)	
E.G. OC (ft)	5405.17	Weir Sta Lft (ft)	
Culv WS In (ft)	5404.01	Weir Sta Rgt (ft)	
Culv WS Out (ft)	5403.57	Weir Submerg	
Culv Nml Depth (ft)	4.71	Weir Max Depth (ft)	
Culv Crt Depth (ft)	3.23	Weir Avg Depth (ft)	
Culv Ful Lngth (ft)		Min Top Rd (ft)	5409.50

Plan: Plan 05 River: Silver Bow Reach:a Riv Sta: 932.6 Profile: 10 yr Culvert ID: Culvert #1 Culv: Culvert #1

Culv Q (cfs)	415.41	Culv Vel In (ft/s)	7.79
# Barrels	1	Culv Vel Out (ft/s)	8.08
Q Barrel (cfs)	415.41	Culv Inv El Up (ft)	5399.70
W.S. US. (ft)	5405.43	Culv Inv El Dn (ft)	5399.40
E.G. US. (ft)	5406.21	Culv Frctn Ls (ft)	0.43
Delta WS (ft)	1.61	Culv Ext Lss (ft)	0.02
Delta EG (ft)	0.92	Culv Ent Lss (ft)	0.47
E.G. IC (ft)	5405.63	Q Weir (cfs)	
E.G. OC (ft)	5406.21	Weir Sta Lft (ft)	
Culv WS In (ft)	5404.80	Weir Sta Rgt (ft)	
Culv WS Out (ft)	5404.29	Weir Submerg	
Culv Nml Depth (ft)	6.01	Weir Max Depth (ft)	
Culv Crt Depth (ft)	3.75	Weir Avg Depth (ft)	
Culv Ful Lngth (ft)		Min Top Rd (ft)	5409.50

Plan: Plan 05 River: Silver Bow Reach:a Riv Sta: 932.6 Profile: 20 yr Culvert ID: Culvert #1 Culv: Culvert #1

Culv Q (cfs)	500.08	Culv Vel In (ft/s)	8.46
# Barrels	1	Culv Vel Out (ft/s)	8.82
Q Barrel (cfs)	500.08	Culv Inv El Up (ft)	5399.70
W.S. US. (ft)	5406.30	Culv Inv El Dn (ft)	5399.40
E.G. US. (ft)	5407.15	Culv Frctn Ls (ft)	0.49
Delta WS (ft)	1.92	Culv Ext Lss (ft)	0.02
Delta EG (ft)	1.08	Culv Ent Lss (ft)	0.56
E.G. IC (ft)	5406.44	Q Weir (cfs)	
E.G. OC (ft)	5407.14	Weir Sta Lft (ft)	
Culv WS In (ft)	5405.47	Weir Sta Rgt (ft)	
Culv WS Out (ft)	5404.88	Weir Submerg	
Culv Nml Depth (ft)	7.58	Weir Max Depth (ft)	
Culv Crt Depth (ft)	4.02	Weir Avg Depth (ft)	
Culv Ful Lngth (ft)		Min Top Rd (ft)	5409.50

Plan: Plan 05 River: Silver Bow Reach:a Riv Sta: 932.6 Profile: 50 yr Culvert ID: Culvert #1 Culv: Culvert #1

Culv Q (cfs)	632.90	Culv Vel In (ft/s)	9.56
# Barrels	1	Culv Vel Out (ft/s)	10.15
Q Barrel (cfs)	632.90	Culv Inv El Up (ft)	5399.70
W.S. US. (ft)	5407.60	Culv Inv El Dn (ft)	5399.40
E.G. US. (ft)	5408.53	Culv Frctn Ls (ft)	0.65
Delta WS (ft)	2.44	Culv Ext Lss (ft)	0.03

Plan: Plan 05 River: Silver Bow Reach:a Rlv Sta: 932.6 Profile: 50 yr Culvert ID: Culvert #1 Culv: Culvert #1 (Continued)

Delta EG (ft)	1.39	Culv Ent Lss (ft)	0.71
E.G. IC (ft)	5407.69	Q Weir (cfs)	
E.G. OC (ft)	5408.53	Weir Sta Lft (ft)	
Culv WS In (ft)	5406.40	Weir Sta Rgt (ft)	
Culv WS Out (ft)	5405.57	Weir Submerg	
Culv Nml Depth (ft)	7.58	Weir Max Depth (ft)	
Culv Crt Depth (ft)	4.59	Weir Avg Depth (ft)	
Culv Ful Lngth (ft)		Min Top Rd (ft)	5409.50

Plan: Plan 05 River: Silver Bow Reach:a Rlv Sta: 932.6 Profile: 100 yr Culvert ID: Culvert #1 Culv: Culvert #1

Culv Q (cfs)	345.04	Culv Vel In (ft/s)	4.93
# Barrels	1	Culv Vel Out (ft/s)	4.93
Q Barrel (cfs)	345.04	Culv Inv El Up (ft)	5399.70
W.S. US. (ft)	5411.73	Culv Inv El Dn (ft)	5399.40
E.G. US. (ft)	5411.75	Culv Frctn Ls (ft)	0.21
Delta WS (ft)	3.69	Culv Exp Lss (ft)	
Delta EG (ft)	0.40	Culv Ent Lss (ft)	0.19
E.G. IC (ft)	5404.97	Q Weir (cfs)	1639.92
E.G. OC (ft)	5411.75	Weir Sta Lft (ft)	327.67
Culv WS In (ft)	5407.28	Weir Sta Rgt (ft)	588.88
Culv WS Out (ft)	5406.98	Weir Submerg	0.00
Culv Nml Depth (ft)		Weir Max Depth (ft)	2.25
Culv Crt Depth (ft)	3.36	Weir Avg Depth (ft)	1.76
Culv Ful Lngth (ft)	70.00	Min Top Rd (ft)	5409.50

Plan: Plan 05 River: Silver Bow Reach:a Rlv Sta: 932.6 Profile: 2 yr Culvert ID: Culvert #1 Culv: Culvert #1

Culv Q (cfs)	199.49	Culv Vel In (ft/s)	6.40
# Barrels	1	Culv Vel Out (ft/s)	8.34
Q Barrel (cfs)	199.49	Culv Inv El Up (ft)	5399.70
W.S. US. (ft)	5403.25	Culv Inv El Dn (ft)	5399.40
E.G. US. (ft)	5403.66	Culv Frctn Ls (ft)	0.51
Delta WS (ft)	1.53	Culv Exp Lss (ft)	0.09
Delta EG (ft)	0.92	Culv Ent Lss (ft)	0.32
E.G. IC (ft)	5403.39	Q Weir (cfs)	
E.G. OC (ft)	5403.66	Weir Sta Lft (ft)	
Culv WS In (ft)	5402.70	Weir Sta Rgt (ft)	
Culv WS Out (ft)	5401.75	Weir Submerg	
Culv Nml Depth (ft)	3.32	Weir Max Depth (ft)	
Culv Crt Depth (ft)	2.35	Weir Avg Depth (ft)	
Culv Ful Lngth (ft)		Min Top Rd (ft)	5409.50

From: USDOT, FHWA HEC-14 (*Hydraulic Design of Energy Dissipators for Culverts and Channels*).

For high tailwater basins (TW/y_o greater than 0.75) the high velocity core of water emerging from the culvert retained its jetlike character as it passed through the basin, and diffused in a manner very similar to that of a concentrated jet diffusing in a large body of water. As a result, the scour hole was much shallower and generally longer. Consequently, riprap may be required for the channel downstream of the rock-lined basin.

General details of the basin recommended in this report are shown on figure XI-1. Principal features of the basin are:

1. The basin is preshaped and lined with riprap.

2. The surface of the riprapped floor of the energy dissipating pool is constructed at an elevation h_s below the culvert invert. h_s is the approximate depth of scour that would occur in a thick pad of riprap, constructed at the outfall of the culvert, if subjected to the design discharge. The ratio of h_s to d_{50} of the material should be greater than 2 and less than 4.

3. The length of the energy dissipating pool is 10(h_s) or 3W_o which ever is larger. The overall length of the basin is 15(h_s) or 4W_o which ever is larger.

DESIGN PROCEDURE

1. Estimate the flow properties at the brink of the culvert. Establish the brink invert elevation such that TW/$y_o \leq 0.75$ for design discharge.

2. For subcritical flow conditions (culvert set on mild or horizontal slope) utilize figures III-9 or III-10 to obtain y_o/D, then obtain V_o by dividing Q by the wetted area associated with y_o. D is the height of a box culvert. If the culvert is on a steep slope, V_o will be the normal velocity obtained by using the Manning equation for appropriate slope, section, and discharge.

3. From site inspection and from field experience in the area, determine whether or not channel protection is required at the culvert outlet.

4. If channel protection is required, compute the Froude number for brink conditions ($y_e=(A/2)^{1/2}$). Select d_{50}/y_e appropriate for locally available riprap (usually the most satisfactory results will be obtained if $0.25<d_{50}/y_e<0.45$). Obtain h_s/y_e from figure XI-2, and check to see that $2<h_s/d_{50}<4$. Recycle computations if h_s/d_{50} falls out of this range.

5. Size basin as shown in figure XI-1.

6. Design procedures where allowable dissipator exit velocity is specified:

   a. Determine the average normal flow depth in the natural channel for the design discharge.

   b. Extended the length of the energy basin (if necessary) so that the width of the energy basin at section A-A, figures XI-1, times the average normal flow depth in the natural channel is approximately equal to the design discharge divided by the specified exit velocity.

7. In the exit region of the basin, the walls and apron of the basin should be warped (or transitioned) so that the cross section of the basin at the exit conforms to the cross section of the natural channel. Abrupt transition of surfaces should be avoided to minimize separation zones and resultant eddies.

8. If high tailwater is a possibility and erosion protection is necessary for the downstream channel, the following design procedure is suggested:

   Design a conventional basin for low tailwater conditions in accordance with the instructions above. Estimate centerline velocity at a series of downstream cross sections using the information shown in figure XI-3. Shape downstream channel and size riprap using figure II-C-1 and the stream velocities obtained above. Material, construction techniques, and design details for riprap should be in accordance with specifications in HEC No. 11 (XI-3) or similar highway department specifications.

Design Example No. 1

Given: 8 ft. by 6 ft. box culvert, Q=800 cfs, supercritical flow in culvert, normal flow depth = brink depth Y_o=4 ft., Tailwater depth TW=2.8 ft.

From: USDOT, FHWA HEC-14 (*Hydraulic Design of Energy Dissipators for Culverts and Channels*).

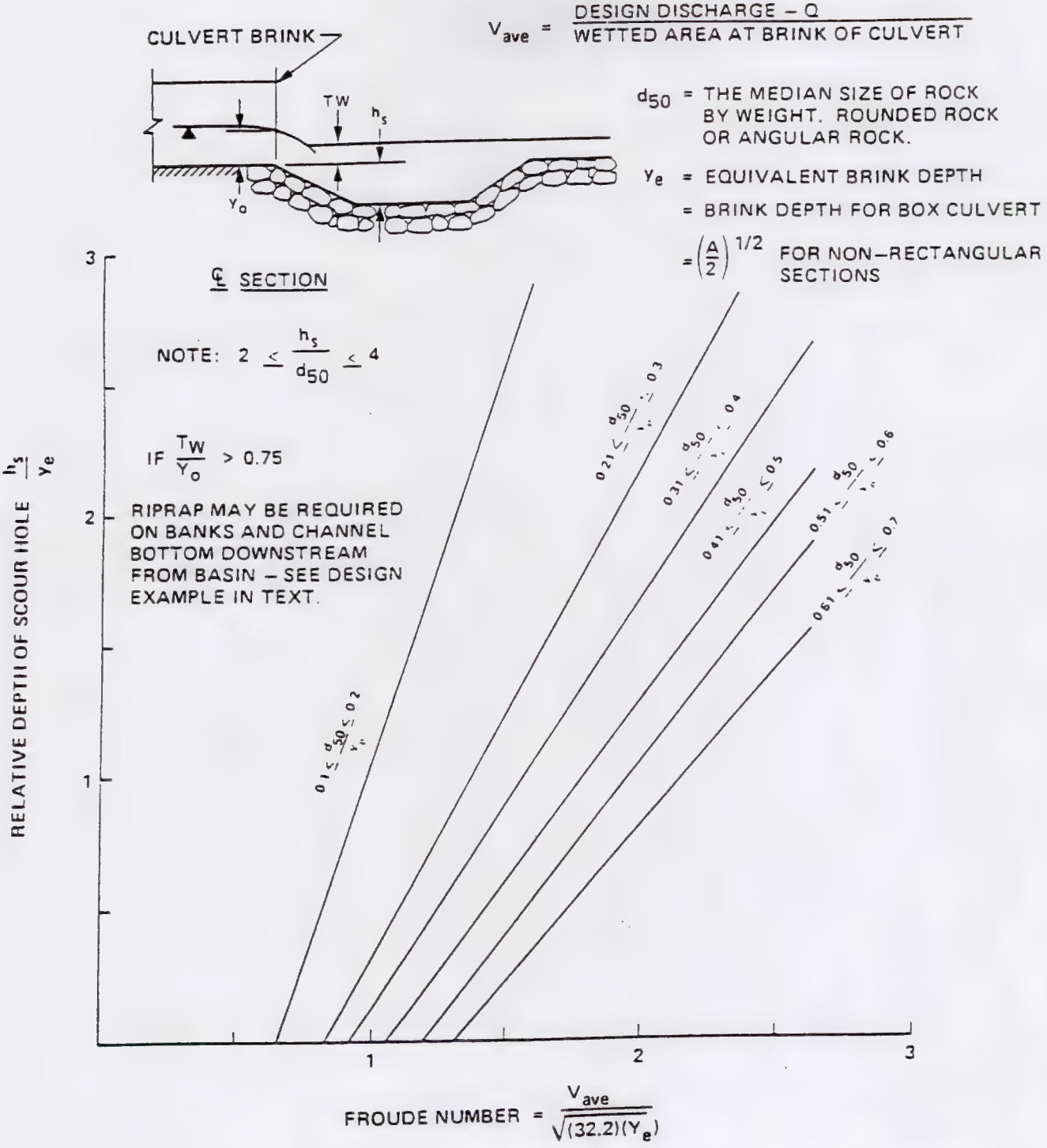

CULVERT BRINK
TW
h_s
Y_o
℄ SECTION
V_{ave} = DESIGN DISCHARGE – Q / WETTED AREA AT BRINK OF CULVERT
d_{50} = THE MEDIAN SIZE OF ROCK BY WEIGHT. ROUNDED ROCK OR ANGULAR ROCK.
Y_e = EQUIVALENT BRINK DEPTH
= BRINK DEPTH FOR BOX CULVERT
$= \left(\frac{A}{2}\right)^{1/2}$ FOR NON–RECTANGULAR SECTIONS
NOTE: $2 \leq \frac{h_s}{d_{50}} \leq 4$
IF $\frac{T_W}{Y_o} > 0.75$
RIPRAP MAY BE REQUIRED ON BANKS AND CHANNEL BOTTOM DOWNSTREAM FROM BASIN – SEE DESIGN EXAMPLE IN TEXT.
RELATIVE DEPTH OF SCOUR HOLE $\frac{h_s}{Y_e}$
FROUDE NUMBER = $\frac{V_{ave}}{\sqrt{(32.2)(Y_e)}}$
1
2
3

FIGURE X1–2. RELATIVE DEPTH OF SCOUR HOLE VERSUS FROUDE NUMBER AT BRINK OF CULVERT WITH RELATIVE SIZE OF RIPRAP AS A THIRD VARIABLE

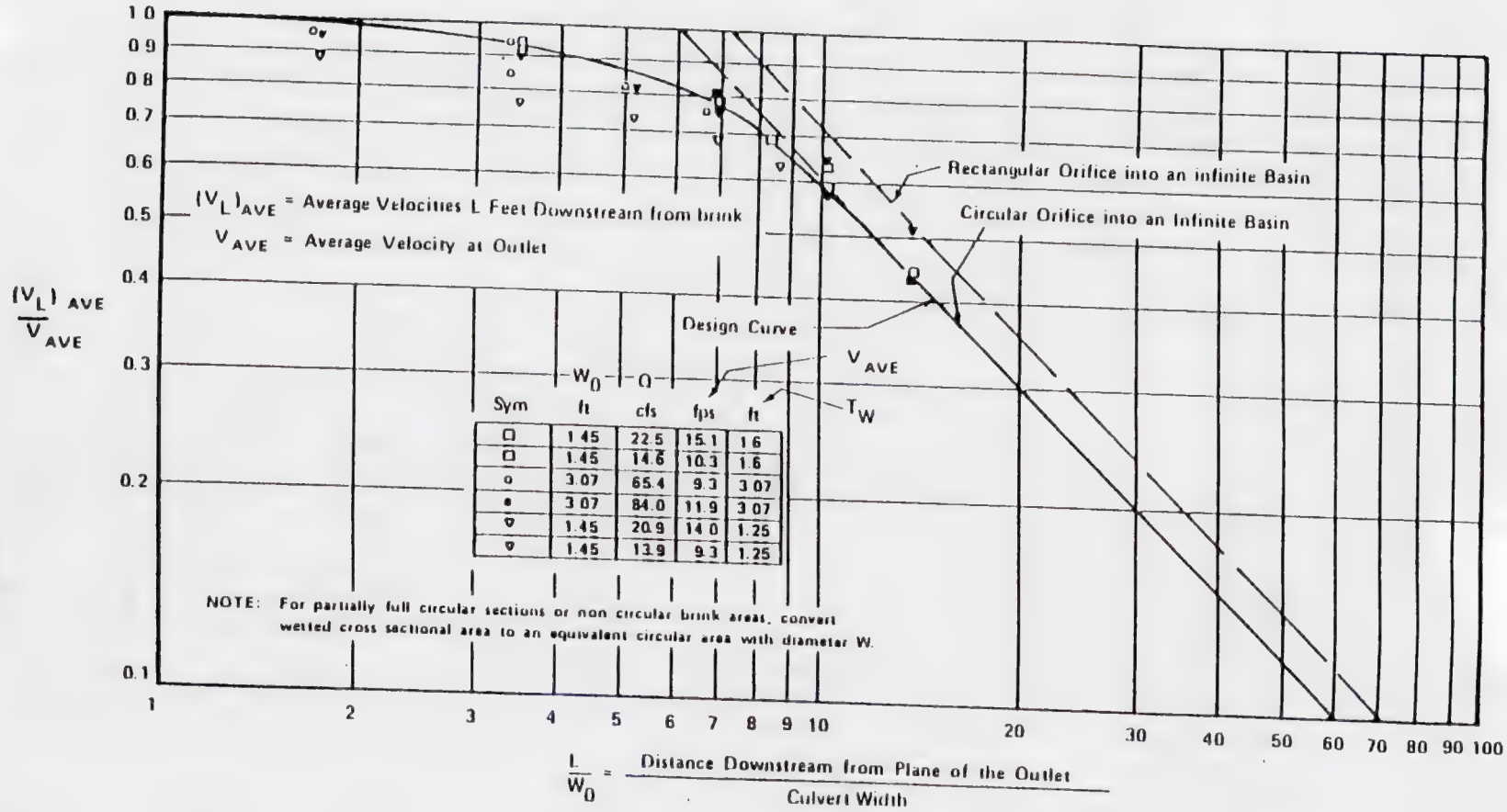

$(V_L)_{AVE}$ = Average Velocities L Feet Downstream from brink
V_{AVE} = Average Velocity at Outlet
Rectangular Orifice into an infinite Basin
Circular Orifice into an Infinite Basin
Design Curve
V_{AVE}
T_W
W_0 Q
Sym ft cfs fps ft
□ 1.45 22.5 15.1 1.6
□ 1.45 14.6 10.3 1.6
o 3.07 65.4 9.3 3.07
• 3.07 84.0 11.9 3.07
▽ 1.45 20.9 14.0 1.25
▽ 1.45 13.9 9.3 1.25
NOTE: For partially full circular sections or non circular brink areas, convert wetted cross sectional area to an equivalent circular area with diameter W.
$\frac{(V_L)_{AVE}}{V_{AVE}}$
$\frac{L}{W_0}$ = Distance Downstream from Plane of the Outlet / Culvert Width
1.0 0.9 0.8 0.7 0.6 0.5 0.4 0.3 0.2 0.1
1 2 3 4 5 6 7 8 9 10 20 30 40 50 60 70 80 90 100

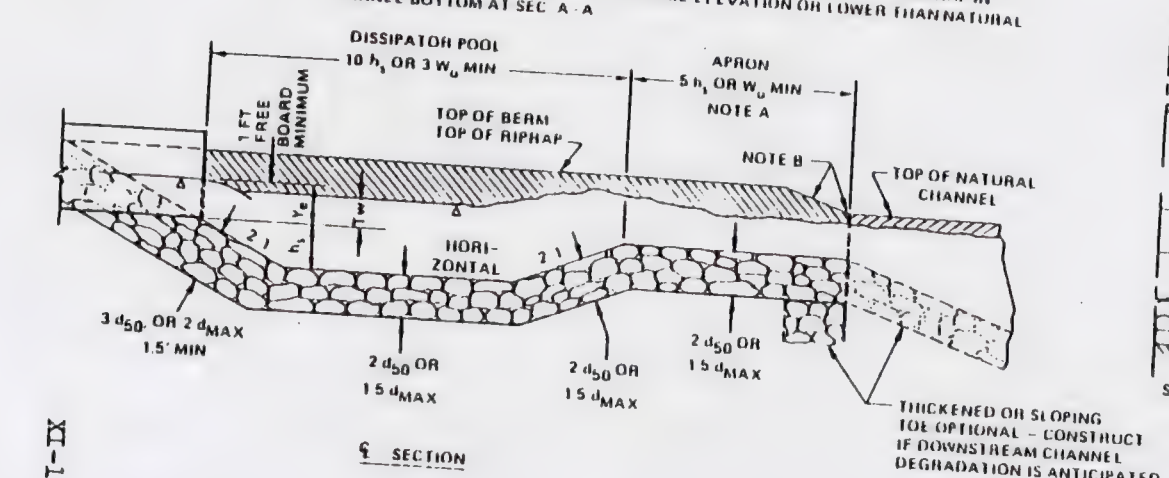
Figure XI - 3 Distribution of Centerline Velocity for Flow from Submerged Outlets from Reference XI - 2 to be used for Predicting Channel Velocities Downstream from Culvert Outlet where High Tailwater prevails. Velocities obtained from the use of this Chart can be used with Figure 2 of HEC No. 11 for sizing riprap (DO not use Figure 1 HEC No. 11, use Mean Velocity Values)

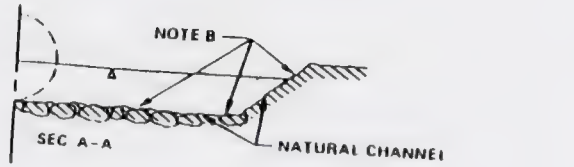
From: USDOT, FHWA HEC-14 (*Hydraulic Design of Energy Dissipators for Culverts and Channels*).

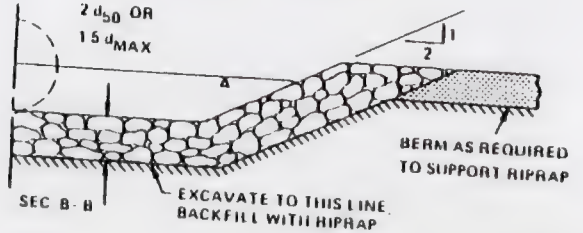
From: USDOT, FHWA HEC-14 (*Hydraulic Design of Energy Dissipators for Culverts and Channels*).

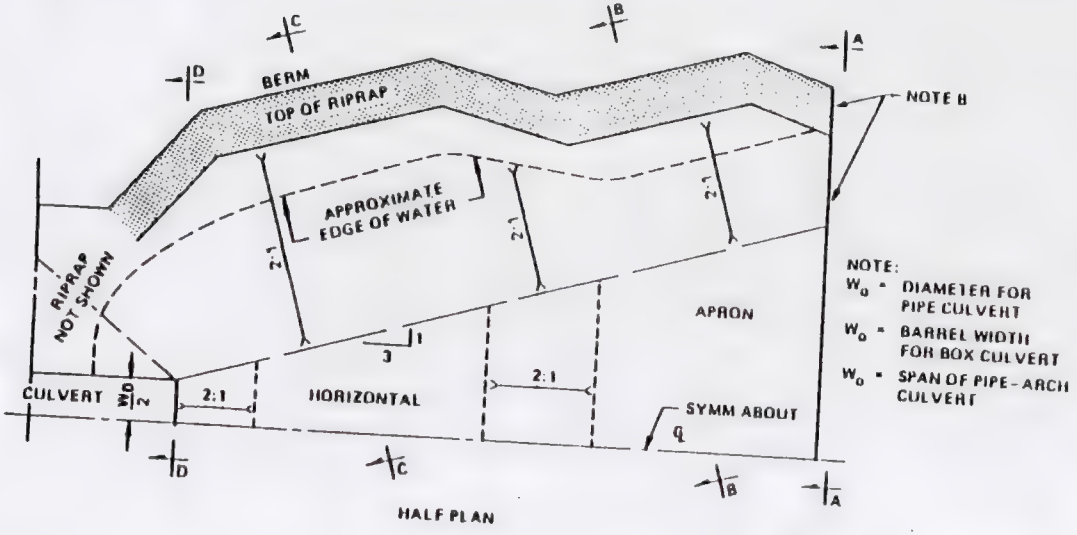
NOTE A – IF EXIT VELOCITY OF BASIN IS SPECIFIED, EXTEND BASIN AS [illegible]NED TO OBTAIN SUFFICIENT CROSS SECTIONAL AREA AT SECTION A A SUCH THAT Q_{des}/(CROSS SECTION AREA AT SEC A-A) = SPECIFIED EXIT VELOCITY

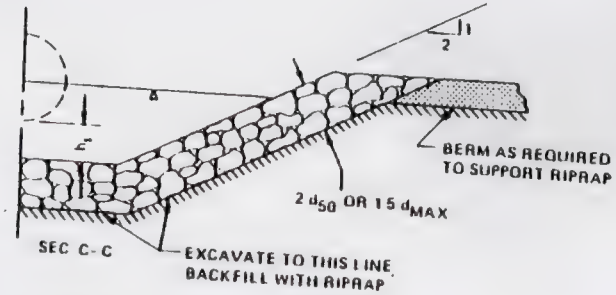
NOTE B – WARP BASIN TO CONFORM TO NATURAL STREAM CHANNEL TOP OF RIPRAP IN FLOOR OF BASIN SHOULD BE AT THE SAME ELEVATION OR LOWER THAN NATURAL CHANNEL BOTTOM AT SEC A-A


DISSIPATOR POOL
10 h_3 OR 3 W_o MIN
APRON
5 h_3 OR W_o MIN
NOTE A
1 FT FREE BOARD MINIMUM
TOP OF BERM
TOP OF RIPRAP
NOTE B
TOP OF NATURAL CHANNEL
HORI-ZONTAL
2:1
3 d_{50} OR 2 d_{MAX} 1.5' MIN
2 d_{50} OR 1.5 d_{MAX}
2 d_{50} OR 1.5 d_{MAX}
2 d_{50} OR 1.5 d_{MAX}
THICKENED OR SLOPING TOE OPTIONAL – CONSTRUCT IF DOWNSTREAM CHANNEL DEGRADATION IS ANTICIPATED
℄ SECTION









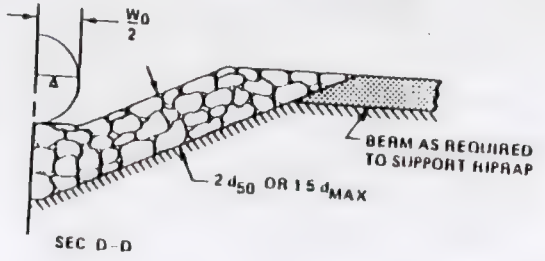


FIGURE XI 1. DETAILS OF RIPRAPPED CULVERT ENERGY BASIN

INTER-FLUVE, INC.

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BOZEMAN, MT 59715
(406) 586-6926
FAX (406) 586-8445

MEMORANDUM

To: *Silver Bow Creek, SSTOU SubArea 1, Reach A*
From: *Shelly Donner*
Date: *4/7/98*
In Regards To: *Reconstruction of County Road*

Reconstruction of Road Prism: A new road prism shall be constructed to the lines and grades of the drawings, as shown on Sheet I 26. The embankment material shall be in accordance with Technical Specification Subset 202.00, Excavation and Embankment, and compacted in 8-inch lifts to 95% of maximum dry density as determined by AASHTO T99. New road surface material shall be Crushed Top Surface Grade 1 as stated in Technical Specification Subset 820.00, Crushed Top Surfacing Course, and placed in a 6-inch lift with a compaction of 95% as determined by AASHTO T99. Road base material shall be Crushed Base Course Grade 1 as stated in Technical Specification Subset 810.00, Aggregate Base Course, and placed in a 6-inch lift and compacted to 95% as determined by AASHTO T99. Compaction testing of the embankment material shall be conducted by the contractor. A minimum of one moisture/density field test per 500 cubic yards of backfill shall be taken, in accordance with Technical Specifications Subset 202.00, Excavation and Embankment.

APPENDIX I

BORROW AREAS DATA

Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

BORROW AREA INVESTIGATIONS

As described in the *Sampling And Analysis Plan Addendum* (Maxim, 1998) Borrow Area Soil In-Place Densities and Sediment Basin Moisture-Density Testing and Soil Sampling section, in-place densities were measured in all the borrow areas except Borrow Area 8 where there were access problems. Composite samples were also collected from each borrow area for moisture-density relationship tests. The results for Borrow Area 1 (BA1) and Borrow Area 10 (BA10) are shown in this appendix.

Three field densities were measured in BA1. The range of in-place dry densities for BA1 is 104.7 lbs/cf (pcf) to 106.0 pcf for an average dry density of 105.2 pcf. Based on the results of the moisture density test from one composite sample, the maximum density for BA1 soils is 125 pcf at an optimum moisture of 9.5%.

Six field densities were measured in BA10. The range of in-place dry densities for BA10 is 74.7 pcf to 99.5 pcf for an average dry density of 89.1 pcf. Based on the results of two moisture-density relationship tests, the average maximum density for the BA10 soils is 100 pcf at an optimum moisture of 20.0%.

References:

Maxim Technologies, Montana Bureau of Mines and Geology, and Reclamation Research Unit, 1998. Sampling and Analysis Plan Addendum, Draft Final, Remedial Design, Subarea 1, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area NPL Site. Prepared for the Montana Department of Environmental Quality and U.S. EPA. January 1998.

MAXIM TECHNOLOGIES INC

Maxim Technologies
1610 B Street. PO Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF IN-PLACE DENSITY

CLIENT: MAXIM TECHNOLOGIES, INC.
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2417
DATE OF SERVICE: 1/29/98
AUTHORIZATION: MAXIM TECHNOLOGIES, INC.
REPORT DATE: 2/02/98

SERVICES: Perform in-place density and moisture content tests to determine the degree of field compaction.

PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
METHOD OF TEST:
DENSITY: ASTM D2922
MOISTURE: ASTM D3017
SPECIFICATION:
DENSITY: NA
MOISTURE:

GAUGE: Troxler
GAUGE SERIAL NO.: 7623
STANDARD COUNTS
MOISTURE - CURRENT: PREVIOUS:
DENSITY - CURRENT: PREVIOUS:
TEST MODE: Direct Transmission
PROBE DEPTH (in.): 8

TEST OF	MATERIALS	MOISTURE/DENSITY RELATIONS OPTIMUM MOISTURE %	MAXIMUM DENSITY pcf	REFERENCE REPORT NO
	NA			

REPORT OF TESTS

TEST NO	LOCATION	FIELD MOISTURE (%)	OPTIMUM MOISTURE (%)	FIELD DENSITY (pcf) WET	DRY	MAXIMUM DENSITY (Pcf)	DENSITY (% max)
1.	BA10-MD-01, 2' Below Grade	13.4	0.0	109.7	96.7	0.0	0.0
2.	BA10-MD-01, 4' Below Grade	15.2	0.0	114.6	99.5	0.0	0.0
3.	BA10-MD-02, 2' Below Grade	7.6	0.0	106.3	98.8	0.0	0.0
4.	BA10-MD-03, 4' Below Grade	21.4	0.0	90.7	74.7	0.0	0.0
5.	BA10-MD-03, 2' Below Grade	15.1	0.0	98.4	85.5	0.0	0.0
6.	BA10-MD-03, 4' Below Grade	21.7	0.0	96.5	79.3	0.0	0.0
7.	BA01-MD-01, 2' Below Grade	9.2	0.0	114.3	104.7	0.0	0.0

Report Of Tests Continued On Page 2

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MAXIM

MAXIM TECHNOLOGIES, INC.
PROJECT NO. 9731701
DATE OF SERVICE: 1/29/98

REPORT NO. 2417

REPORT OF TESTS (Continued)

TEST NO	LOCATION	FIELD MOISTURE (%)	OPTIMUM MOISTURE (%)	FIELD DENSITY (pcf) WET	FIELD DENSITY (pcf) DRY	MAXIMUM DENSITY (Pcf)	DENSITY (% max)
9.	BA01-MD-02, 2' Below Grade	7.9	0.0	114.4	106.0	0.0	0.0
10.	BA01-MD-02, 4' Below Grade	9.4	0.0	114.8	104.9	0.0	0.0
11.	BA02-MD-01, 2' Below Grade	2.5	0.0	111.6	108.9	0.0	0.0
12.	BA02-MD-01, 4' Below Grade	12.0	0.0	124.7	111.3	0.0	0.0
13.	BA02-MD-02, 2' Below Grade	5.7	0.0	114.3	108.1	0.0	0.0
14.	BA02-MD-02, 4' Below Grade	6.9	0.0	113.1	105.8	0.0	0.0
15.	BA17-MD-01, 1.5' Below Grade	30.8	0.0	94.2	72.0	0.0	0.0
16.	BA17-MD-01, 3' Below Grade	36.6	0.0	99.2	72.6	0.0	0.0
17.	BA17-MD-02, 1.5' Below Grade	29.3	0.0	96.7	74.8	0.0	0.0
18.	BA17-MD-02, 3' Below Grade	36.3	0.0	102.5	75.2	0.0	0.0
19.	BA17-MD-03, 1.5' Below Grade	7.0	0.0	112.3	105.0	0.0	0.0
20.	BA17-MD-03, 3' Below Grade	26.7	0.0	84.1	66.4	0.0	0.0
21.	BA17-MD-04, 2' Below Grade	28.4	0.0	100.7	78.4	0.0	0.0
22.	BA17-MD-04, 4' Below Grade	32.1	0.0	101.7	77.0	0.0	0.0

Technician: Todd Kuxhaus
Staff Engineer

Report Distribution:
(1) MAXIM TECHNOLOGIES, INC.

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser

Jeremiah B. Bowser, P.E.
Engineering Manager

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REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2456
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/17/98

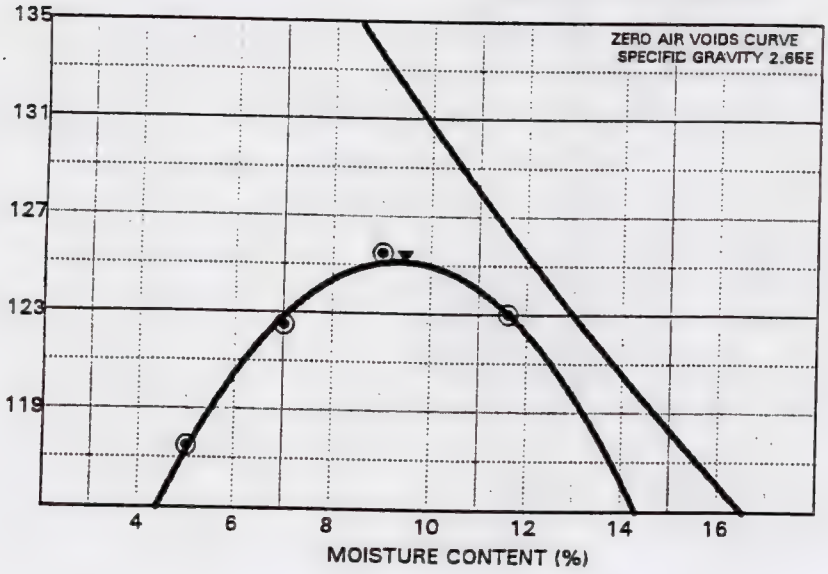
SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: BA-01-MD-02

TEST DATE: 2/05/98
MATERIAL: NATIVE
CLASSIFICATION: POORLY GRADED SAND
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-A

REPORT OF TESTS



MAXIMUM DENSITY, PCF: 125.0

OPTIMUM MOISTURE (%): 9.5

E = Estimated Value

Technician: Jesse Whitford
Engineering Technician

Report Distribution:
ARY FISCHER
ODD KUXHAUS

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser, P.E.
Engineering Manager

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REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2458
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/17/98

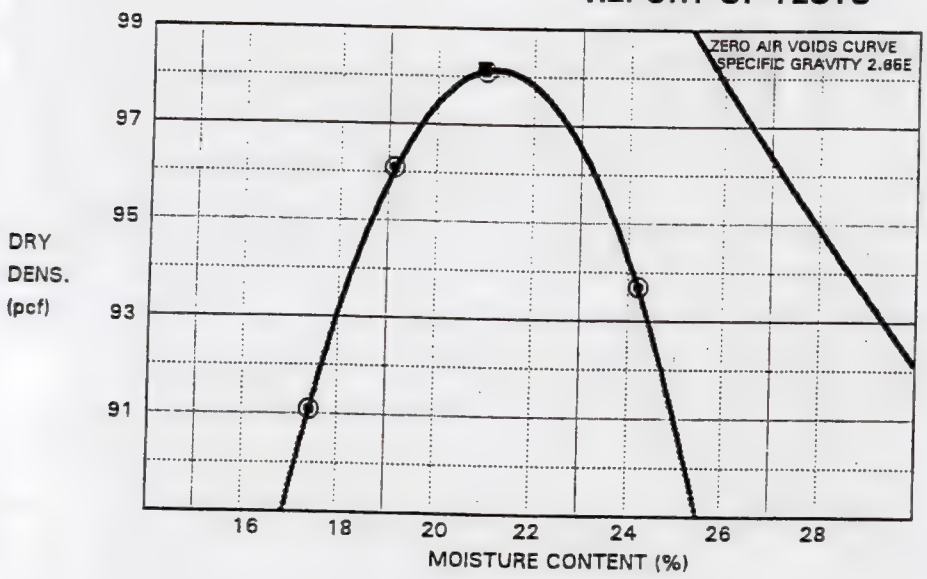
SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: BA10-MD-01

TEST DATE: 2/06/98
MATERIAL: NATIVE
CLASSIFICATION: SILTY SAND
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-D

REPORT OF TESTS



MAXIMUM DENSITY, PCF: 98.0

OPTIMUM MOISTURE (%): 21.0

E = Estimated Value

Technician: Jesse Whitford
Engineering Technician

Report Distribution:

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(1) TODD KUXHAUS

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REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
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ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2459
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/17/98

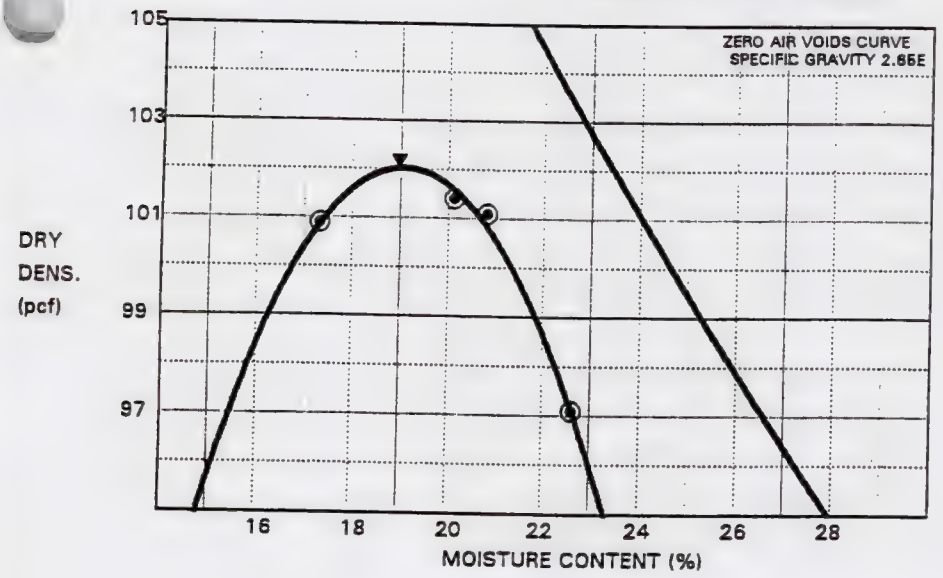
SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: BA10-MD-02

TEST DATE: 2/06/98
MATERIAL: NATIVE
CLASSIFICATION: SILTY SAND
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-A

REPORT OF TESTS



MAXIMUM DENSITY, PCF: 102.0

OPTIMUM MOISTURE (%): 19.0

E = Estimated Value

Technician: Jesse Whitford
Engineering Technician

Report Distribution:
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APPENDIX J

REVEGETATION

Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

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APPENDIX J: REVEGETATION

This appendix contains important elements of the revegetation plan. One fundamental of this plan is that seeded and planted species are matched to habitats to the extent possible. This is done in design components, and later explained in a discussion of hydrologic zones, soil and coversoil classes, and their integration into revegetation habitat types. Following those topics, plant nutrition is discussed relative to the revegetation plan. Three basic approaches to nitrogen nutrition used in this design and other nutrients are identified and discussed. Mycorrhizae, important not only for plant performance but also weed control, also are discussed in this appendix.

J1. DESIGN COMPONENTS

For each revegetation unit (i.e., plant habitat), this design plan proposes a revegetation strategy that includes physical treatments, soil amendments, propagule mixtures and techniques. This plan incorporates competitive and temporal relations and, to the extent possible, fosters diversity, weed and erosion control, and provides for special values or uses.

J1.1 Substrates

In revegetating from seed, the quality and condition of the seedbed are primary factors. Cultivation is necessary to provide a suitable environment for seed germination and plant establishment and development, as well as controlling weeds and in some cases storing moisture.

Plant establishment practices must be approached with a degree of flexibility, and changes in these practices may be approved by the owners' representative based on field conditions, e.g., initial surface conditions. Mineral fertilization and mulching also could be considered cultivation practices, and since a fungal component of vesicular-arbuscular mycorrhizae (VAM) must be placed into the soil, VAM inoculation is treated under cultivation. A recent handbook compiled by the Wyoming Department of Environmental Quality and USDI Office of Surface Mining (1996) covers the details of site preparation. Appendix A contains some technical specifications.

Establishing nutrient cycling will be a major challenge at all sites, and mineral fertilization will be a standard treatment during seedbed preparation. Our general prescription for nonwetland sites is nitrogen fixation, a biological approach. Should this symbiosis fail to establish and where a weedy seed bank is present, incremental light fertilization is prescribed for non wetlands. In some circumstances, an organic amendment will be incorporated into the soil at the time of seedbed preparation. This can have biological as well as physical and chemical benefits. These three basic options for establishing nitrogen cycling are discussed later.

Cultivation

The following treatments generally apply to the transition, subirrigated, and upland zones. Mulching and VAM are inappropriate for wetlands, and the potential for mechanical treatments and fertilization may be very limited.

1. Ripping to a depth of 18 inches will be necessary where heavy, rubber-tired equipment has compacted soils/coversoils. As a general guideline, ripping will be required when the bulk density of sandy loams exceeds 1.8 g/cc, or when the bulk density of clay loams exceeds 1.5 g/cc. The owners' representative will determine where ripping is necessary.

2. Work the coversoil to depth with a chisel plow (e.g., 6-12 inch depth, two-feet or closer tooth spacing), incorporating P and K as prescribed. The following fertilization prescriptions assume incorporation into the upper six to eight inches.

   Based on limited sampling and a target concentration of > 250 ppm of potassium, borrow material from BA 10 do not need potassium additions. In situ soils were variable, with a sandy loam requiring none, a gravelly sandy loam requiring 120 lbs./K_20 per acre, and a silty loam 270 lbs./K_20 per acre. While it is unknown whether texture and potassium concentration is well correlated, it is known that coarse textures retain less potassium due to lower CEC. Moreover, high concentrations of potassium will inhibit neither nitrogen fixation nor VAM. Therefore, the standard treatment of in situ soils calls for 100 lbs./K_20 per acre for textures of sandy loam and coarser, and 250 lbs./K_20 per acre for loams and finer textures.

   Based on the same limited sampling and a target of >10 ppm of phosphorus (Olsen method), borrow area topsoils, in situ soils have adequate phosphorus. The rather low target concentration was selected to encourage VAM establishment. Borrow Area 10 materials used as coversoil should receive 20-25 lbs./P_20_5 per acre.

3. A good seedbed must be prepared by disking, chisel plowing, cultipacking, or other appropriate methods. The objective here is a clod-free seedbed suitable for mulching and planting. Where compost will be applied to coversoils, it will be applied and incorporated during the chisel-plowing or disking phase of seedbed preparation, prior to mulching.

   Important aspects of seedbed preparation are modeled on agronomic practices. The same practices that promote establishment of desired, planted species provide a fine habitat for weeds. Many native plants have slow-growing seedlings that cannot compete with weeds in an agronomic setting (Meyer and Kitchen, 1995). Plants adapted to drought (upland native perennials) usually sacrifice growth rates (Jones, 1983), which may leave them at a competitive disadvantage with weeds that typically weather droughts in a protected state. Agronomic practices necessitate weed control measures, which are discussed later in this section.

   A commercial VAM inoculum, (VAM-80) based on the fungi *Glomerus intraradices,* is prescribed for all upland and subirrigated sites and the transition zone. The product contains root fragments and fungi spores in a calcined clay carrier. It can be applied using an imprinter or at least one type of fertilizer box. On the Butte Hill, it has been applied with minor modifications to a seeder. For details, review two manuscripts by Ted St. John (1996, 1998). Details will be covered in the revegetation contract. The potential to store viable fungi in the soil is greatest in dry soils and least in moist soils. It is recommended that this product be bought fresh and not be subjected to rapid, extreme temperature changes. For example, this product should not be shipped from California and abruptly applied into almost frozen soil.

4. All in situ soils, topsoils, and borrow materials contained almost no nitrogen. Nitrogen fertilizer should be applied in drill rows where drill seeding is used, and near the surface otherwise. Nitrogen fertilization should be concurrent with or shortly in advance of seeding. A target of 6 ppm of nitrogen calls for the addition of about 25 pounds of urea per six-inch-acre slice. This low N concentration will not inhibit nitrogen fixation or overly stimulate agronomic weeds. Urea is recommended at this stage to provide a reduced form of nitrogen for nitrification. Approximately 10 pounds nitrogen per thousand pounds of mulch also is recommended (Plantenberg, 1997, pers. comm.). Where 1.5 tons of mulch/acre is applied, this would bring the total application to 90 pounds of urea per six-inch-acre slice. (Urea is 46% nitrogen.)

5. Our general prescription for nonstreambank sites calls for dormant seedings in October or later, with primary germination expected the following spring. Seed will be planted with a rangeland drill or disc-type drill, simultaneously applying 30 lbs./A urea in the drill rows insofar as possible. The idea is to place the nitrogen with seed of desirable species in the hope that it will benefit them, and at the same time be largely unavailable for weeds. An initial application of 20-40 pounds of actual nitrogen/acre just before planting will increase seedling vigor, and an additional application following seedling emergence will help assure a good stand of grass (Bluhm, 1992).

   Care of seed prior to planting is important; seeds are live plants, but dormant. We assume that the revegetation contractor will have seed boxes for standard seed, small seed, and trashy seed if appropriate, and experience calibrating drills and general knowledge of seeding equipment. Depth of seeding should vary within the upper centimeter of soil to accommodate the requirements of light and heavy seeds combined in a seed mixture. Seeding should be deeper in coarse coversoils than in loams. Where hydroseeding and hydromulching are used, they will be done separately.

   Broadcast seeding (including hydroseeding) is an option especially well-suited for seed enhanced by light, which includes most wetland seed. Both techniques are better-suited to small seed than large. Germination and establishment are low compared to drill seeding, and the general rule is to double drill seeding rates. Where drill seeding is prescribed in this revegetation plan, but for some reason broadcasting is substituted, applications rates will be doubled to tripled. Rolling will follow hydroseeding where practicable to ensure maximum seed/soil contact.

6. Mulching is being used in some areas. At surface mines, mulching is less popular than previously because it creates such a uniform seedbed. The alternative is a rough seedbed with contours perpendicular to the slope. This has been found to be effective in controlling erosion and better than mulching in establishing diverse plant communities because of the variable microtopography it creates.

   Where mulching will be used, a certified weed-free product is prescribed immediately after seeding. A rate of approximately 1.5 tons/acre of straw from a cereal grain (e.g., barley, wheat) is recommended. A tubgrinder and crimper are the usual equipment. Alfalfa hay mulch also is approved. The organic nitrogen certainly is desirable, and it would reduce the need for mineral fertilization, but the brittleness of alfalfa hay limits its effectiveness in erosion prevention.

   Regardless of type, mulches reduce erosion and evaporative water loss, help prevent soil crusting, and reduce soil surface temperature (Linder and others, 1996). In the SSTOU, we foresee some sites receiving final grading well in advance of dormant fall seeding. Crimped mulch plays an important role in preventing soil erosion until plants are established, but the organic matter also is important in promoting soil microorganisms in conjunction with urea. Mulch in the soil is as important as what sticks up through the surface.

   In Reach A, straw mulch serves another important function in revegetation. Most borrow materials completely lacked protozoa, without which nitrogen cycling would be nonexistent (Ingham, 1998, pers. comm.). There are thousands of protozoa on each gram of straw or hay. Mulching will provide the protozoa that eat bacteria and fungi that otherwise would tie up nitrogen.

   If mulching establishes a successful preparatory crop, the revegetation seed mix can be no-till drilled at the appropriate time. If not, and a proper seedbed is absent at the time of seeding, the soil will have to be disked, seeded, and re-mulched where prescribed.

6. Depending on the accumulation of standing and surface litter, mowing and harrowing three to five years following planting may benefit nutrient cycling by putting standing and surface litter into intimate contact with the soil.

7. To establish nitrogen fixation, about a dozen *Rhizobium* inocula for specific legumes are available from seed vendors. Inocula should be bought fresh and applied to legume seed with a sticky liquid (e.g., sugar water) just prior to planting. Many legumes need a firm seedbed, which may require rolling of light coversoils.

   Where legumes fail to establish effectively, subsequent light applications of fertilizer are important in establishing nitrogen cycling. Experience is the best teacher, but as a general prescription, we recommend 30 lbs./A of urea (puts about 7 ppm of nitrogen in upper six inches of soil) twice at least a month apart in the late-May to mid-July period for approximately three to five years. If an effective nitrogen fixing species is well-represented in revegetation, fertilization is unnecessary.

   All in situ soils, topsoils, and borrow materials contained almost no nitrogen. A target of 8 ppm of nitrogen calls for the addition of about 35 pounds of urea per six-inch-acre slice. This low N concentration will not inhibit nitrogen fixation or overly stimulate agronomic weeds. Urea is recommended at this stage to provide a reduced form of nitrogen for nitrification. Approximately 10 pounds nitrogen per thousand pounds of mulch also is recommended (Plantenberg, 1997, pers. comm.). Where 1.5 tons of mulch/acre is applied, this would bring the total application to 100 pounds of urea per six-inch-acre slice. (Urea is 46% nitrogen.) An additional 35 lbs./A of urea will be applied in drill rows at the time of seeding.

Special Sites and Treatments: Inundated Wetlands, Repositories, and Weedy Uplands

One class of wetlands, deepwater inundated wetlands, need a special topographic condition due to the limits of continual inundation on plant establishment and nutrient cycling. Most created wetlands have water control structures, but ours will not. Water levels usually are manipulated to encourage vegetation establishment in created wetlands during the first three to five years (Hammer, 1997). "Wetland management" and "water level manipulation" are virtually synonymous. The water levels of created wetlands along the SST OU will be unregulated, with water levels fluctuating irregularly with natural hydrologic conditions. For rooted emergents and submergents, virtually all establishment from seed and considerable vegetative propagation occurs when the soil is exposed.

Our approach is to create an irregular microtopography in areas that will become inundated wetlands, coupled in some cases with deliberate planting of wetland herbs. This is a far more reliable propagation method than seeding. Mounds, peninsulas, islands, and topographic features of any shape will provide sites with varying depth and frequency of inundation and exposure. The exact microtopographic details can be decided during construction with the approval of the owner's representative.

A topographically diversified wetland limits exposure to negative aspects of prolonged inundation. Because of the potential for organic matter accumulation, microtopographic variations should be fairly pronounced. For example, topographic highs could be at the elevation of the water surface in an average May-June. The tops of other topographic features could be a third of a meter lower. The ground surface in an inundated wetland could vary from the spring water surface to perhaps 1.5 meters below the water surface. (The vast majority of wetland plants is limited to water depths of around one meter [Hammer, 1997].) Rather than have the entire wetland, except margins, either reduced or aerated, redox conditions would vary with ground elevation throughout the wetland. The more gradual the topographic changes, the greater the area that would experience different redox conditions and depths of free water for a given change in water elevation.

Repository revegetation is critical because of the role plants plays in preventing water percolation through the soil profile. Nitrogen fixation is desired because plants growing on fertile soils are more efficient in extracting soil moisture than those growing on infertile soils. Nitrogen fixation cannot be guaranteed to establish or persist, so organic amendment in the form of compost is prescribed at the rate that brings the organic matter content of the upper six inches to 2.0%. Compost is actively decomposing and the amount of organic matter remaining in one year may be closer to 1.5% (Jacobsen, 1998, pers. comm.). Adding compost is the surest route to effective nutrient cycling. Due to the critical role of vegetation on repositories, compost will be evaluated not only for organic matter and nutrient concentrations (to assure they complement nitrogen fixation and VAM, discussed later), but also beneficial soil organisms.

Another special treatment for repositories is that reapplied topsoil containing weed seed will be applied more than one foot below the surface and covered with BA10 coversoil so that weed seed is not brought to the surface during compost incorporation.

Within the floodplain, planting substrates will contain little weed seed if provisions of the weed control plan are implemented. There will be areas above the remediated floodplain where haul roads, staging areas, ditch construction, and borrow excavation disturb the land. Soil textures are unknown but probably loamy sands to sandy loams. Weed seed will be abundant in topsoil. Chemical seed treatments have been ruled out because they devastate soil microbe populations, may contaminate groundwater, and are very expensive. Limited sampling indicates that there is no need for phosphorus or potassium fertilization, but coarse textures may limit plant performance.

Here chemical weed control will be needed, probably in the second year following planting and perhaps subsequently. This means that nitrogen fixation cannot be relied upon to assist plant nutrition while nitrogen and carbon reservoirs accumulates. To an extent, compost addresses plant nutrition and also litter decomposition, but it is costly, on the order of $2,500 to bring the organic content of the upper six inches of coversoil to one percent. Therefore, our general prescription for these areas calls for the program of incremental mineral nitrogen fertilizer application described previously.

However, it is important that the costs and benefits of good compost addition be evaluated relative to its use elsewhere. On approximately two acres of weedy upland, enough compost amendment will be added to bring the organic matter content of a six-inch-acre slice to one percent. This will be seeded to the same set of grasses as other portions of the weedy upland category. Both will receive incremental urea fertilization for approximately five years.

J1.2 Seeding and Planting Prescriptions for Revegetation Habitat Types

For each important revegetation habitat type defined and discussed later in this appendix, a revegetation strategy identifies a set of appropriate plant species and practices for establishing them. The revegetation plan for Reach A is portrayed in Figure set J1. As a practical matter, tiny units of differing site types may be too small to treat individually (3.12.2.2). For example, small units of transition-zone hydrology within larger units of saturated wetlands will be seeded as saturated wetlands. In another example, there is usually a band of upland soils at the edge of the disturbance boundary. Some will be clean Class 2 fill, some will be weedy Class 1 in situ soil. Because of the small area and sometimes intricate pattern, both upland units can be treated as weedy uplands.

Although revegetated plant communities do not always establish in a predictable way from propagule mixes and plantings, site factors must define revegetation units and dictate initial revegetation strategies. Nutrient strategies, also discussed in this appendix, have been incorporated into each prescription, although the biologic ones may not be obvious to those readers unfamiliar with the species prescribed.

Some species prescribed for Subarea 1 have been known to dominate strongly elsewhere, sometimes to the extent that planting them is undesirable. In this category are some clovers (*Trifolium pratense*, *T. hybridum*) and fowl bluegrass (*Poa palustris*). The dominating tendencies of species cannot always be predicted, and the above-mentioned species have not shown a tendency for competitive dominance locally. Tufted hairgrass (*Deschampsia cespitosa*) is a dominant in wetlands and transition-zone sites elsewhere in Montana, but a rather weak species locally on uncontaminated sites. Even such a competitive excluder as reed canarygrass (*Phalaris arundinacea*), which is present a few places in the SST OU and upstream along Blacktail Creek and tributaries, has shown no dominating tendency on granitic substrates here. In contrast, bentgrasses (*Agrostis stolonifera* and *A. tenuis*) have dominated some previous revegetation efforts along Silver Bow Creek, but their proclivity to invade clean sites locally is yet poorly known. Species that have shown invading tendencies in the Upper Clark Fork, such as creeping foxtail (*Alopecurus arundinaceus*) and meadow foxtail (*A. pratensis*), are not being planted along Silver Bow Creek.

Risk always is associated with revegetation attempts. For example, soil moisture conditions in the upland and subirrigated zones play important roles during the critical establishment phase. In ponded wetland areas, few plants will establish in open water; rather, they establish during temporary periods when the substrate is exposed -- factors over which we have little control. By far the greatest risk during the establishment phase is that of high-intensity summer storms peeling topsoil from slopes and carrying it downstream. No doubt there will be some seeding and transplanting failures, but if properly planned, revegetation successes will predominate. We expect revegetated plant communities to function with minimal subsequent treatments that are not part of revegetation prescriptions.

Following construction activities and a few weeks to establish equilibrium, sampling depth to groundwater and soil texture will either confirm the plan or call for revision so that the appropriate strategy is applied to the actual hydrologic zone. The plan will be redrawn where inappropriate hydrologic regimes have been used for planning purposes. Even if it needs to be amended following construction, the plan is necessary to secure approximate amounts of plant propagules for the project and to provide a basis for revegetation bidding.

Streambanks

Streambanks usually are topographically distinct areas of relatively steep gradient and abrupt transition between the stream channel and adjacent slopes or terraces. For revegetation purposes, the streambank zone extends back 10 feet from the top of the bank. Revegetation details are contained in Section 3.8.4.

Wetlands

Deepwater Wetlands and Margins

The zonation of vegetation in and around wetlands is due mainly to the influence of water depth (Hammer, 1997; Daubenmire, 1968). Deepwater wetlands encompasses wetland sites and shallow aquatic habitats inundated for most of the growing season, usually with more than 0.3 meters of standing water but less than 1 meter during the wetter periods. Most will not have inlets or outlets. Substrate environments will be strongly reducing except at margins. Rather few rooted plant species are adapted to these habitats. Terrestrial species will invade these sites only during prolonged, severe droughts. No imminent weed threat has been recognized unless aggressive grasses and cattails are considered weeds.

Based on the postremediation topography and anticipated hydrology, three significant deepwater wetlands and a few small inundated wetlands could be created. Without berms, however, surface water will drain to the stream. Deepwater wetlands are not being built in the initial construction scenario, but may be constructed later. An incidental acreage of about one-tenth of an acre is initially expected.

A variety of propagules will arrive quickly via water, air, and waterfowl. Ponded sites will be colonized by algae and free-water vascular plants such as duckweed (e.g., *Lemna trisulca*). Pond margins would revegetate quickly, probably with cattails, without special effort. For example, 79% of the species and 90% of the plants found in some created wetlands in mined lands were volunteers (Iverson and Wali, 1982). Shaking ripe spikes of cattails (*Typha*) over the water would accelerate cattail establishment. However, Levine and Willard (1990) concluded that natural colonization of wetlands is often inappropriate because of the tendency for monotypic stands (usually cattails) to develop. Naturally colonized wetlands in Wisconsin had become strongly dominated by cattails with a fringe of willows and cottonwoods after two years (Reinartz and Warne, 1993). The tendency of cattails to pioneer and if so to dominate along the SST OU will be more pronounced on finer-textured substrates, whereas cattail establishment is limited on coarse substrates (Weiher and others, 1996).

ARARs mandate more diverse plant communities, and it may be possible to limit cattail dominance by seeding other adapted species. "Preemptive competition" from seeded species may allow other perennial clonal species to occupy space that would have been quickly taken by cattails. Reinartz and Warne (1993) concluded that "Early introduction of a diversity of wetland plants may enhance the long-term diversity of vegetation in created wetlands." To promote more diverse, native margin vegetation, the prescription is to seed two bulrushes and two sedges before *Typha, Phalaris, Alopecurus arundinaceus,* etc. colonize the site.

The two bulrushes, *Scirpus microcarpus* and *S. acutus,* often have a dormant seed that is activated by stratifying wet seed in a refrigerator, followed by drying for storage. The two sedges are *Carex utriculata* and *C. aquatilis*. The fruits of sedges (perigynia) are often sold as seed, but it is seed that should be planted, and scarification is not difficult (Hoag and Sellers, 1995). These four species should be broadcast onto the exposed ground surface. To establish from seed, wetland plants need water, heat, and light. Hoag and others (1994) found that "even a thin covering of soil will significantly decrease germination." Seeding must be done when water levels are low. A dormant fall broadcast seeding is prescribed. This will alleviate the need to overcome cold dormancy stratifying seed in water in a refrigerator.

Still, diversity is not assured: Weiher and others (1996) found that high diversity - low biomass wetlands are not easily created. Another study (Noon, 1996) found that there was a 60% reduction in richness on sites that evolved over an 11-year time frame. Given the unreliability of seed as a means of establishing true wetland plants, planting plugs along pond margins is prescribed using the same species prescribed for shallow inundated wetlands. Density is one wetland plug per linear yard.

Shallow Inundated Wetlands

Up to two acres of shallow ponded wetlands are possible in Reach A. These delineations are based on groundwater and ground surface elevations. Water will not actually pond unless berms are constructed at portions of the perimeters, an issue not yet decided. In revegation planning, these areas are being treated as shallow ponded wetlands.

Shallow inundated wetlands will be inundated for a significant portion of the growing season in an average year. Usually, the average depth of inundation will be less than 0.3 meters. Shallow wetlands require relatively flat sites, with less topographic relief than deepwater inundated wetlands. Even in dry years, sites will be saturated to near the ground surface for at least a few weeks during the growing season. Substrate environment will be primarily reducing but oxidized for portions of the growing season too. Plants of inundated wetlands thrive in a broad range of soil types, but each species has optima and ranges for that and other environmental factors. For the species desired here, midsummer planting is superior to seeding as means of establishing persistent revegetation in all but cost.

No special weed threat is foreseen, although competitive introduced grasses planted in Lower Area One could nullify plugging efforts. The weed of greatest potential, purple loosestrife, has not yet observed in the vicinity of the SST OU.

Plug Plantings

Plug planting is superior to seeding in establishing desirable wetland plants. Plugs will be planted at an average density of one per 2.25 square feet. This is the standard for all plugs collectively. Due to the large wetland acreage and cost of plugs, only a portion of these wetlands will be planted in the form of mosaics throughout the unit. This strategy is more effective than planting large areas at low density (Hoag, 1998, pers. comm.).

In Subarea 1, different plantings were planned for the relatively coarse materials of Class 1 and Class 2 soils vs. Class 3 soils. In Reach A, less than one-tenth of an acre of planting has been prescribed for shallow inundated wetlands, about half each in Class 2 and Class 3 soils. Two different prescriptions are impractical for such a small area, so a single ratio of species will be used. Without berms, there will be no inundated wetlands, and the species appropriate for saturated wetlands can be used.

30%	Beaked sedge(*Carex utriculata*)
30%	Water Sedge (*Carex aquatilis*)
15%	Water smartweed (*Polygonum amphibium*)
10%	Small-fruited bulrush (*Scirpus microcarpus*)
10%	Collectively: *Scirpus acutus (*hardstem bulrush), three-square bulrush *(Scirpus pungens)*, and bur-reed *(Sparganium emersum)*, depending upon price and availability. This last category is optional.

Seeding

Unfortunately, the acreage of shallow inundated wetlands is too great to plant fully as a matter of cost. Of necessity, we fall back on seeding. The seed mix must stabilize the site and yet not be too competitive with plugs. Furthermore, it must contain an easily established species (fowl bluegrass) as well as seeds of those species best-adapted in the long run (three *Carices*), even though their establishment may take time.

Typically, plants of one group die as the water level changes, highlighting the importance of seed banks in wetland habitats where water levels fluctuate significantly. This seed bank allows prairie marshes to regenerate in a natural cycle that may span 5-30 years (van der Valk and Davis, 1978). Our seeding strategy builds on this fact and the longevity of many wetland seeds.

Germination of many wetland species is dependent upon their exposure to unfiltered sunlight (Cresswell and Grime, 1981; Hoag and others, 1994). More species from a marsh seed bank germinated on a moist substrate than a submerged one (Smith and Kadlec, 1983). In prairie glacial marshes, drawdown and submersed treatments had only 25% of their species in common; as little as 2 cm of standing water has a significant impact on which seeds germinate (van der Valk and Davis, 1978). They documented a dynamic in which emergent, mud flat and submersed/free-floating species replaced one another in response to inundation and drawdown. Plants of one group died as the water level changed, highlighting the importance of seed banks in wetland habitats where water levels fluctuate significantly.

2 lbs./A	Fowl bluegrass *(Poa palustris)*
1 lb./A	Baltic rush *(Juncus balticus)*

2 lb./A	Tufted hairgrass *(Deschampsia cespitosa)*
2 lb./A	American mannagrass (*Glyceria grandis*)
1/4 lb./A	Northern reedgrass *(Calamagrostis stricta* or *C. inexpansa)* if available
1 lb./A	Two of the three major adapted sedges, (water sedge, beaked sedge, and Nebraska sedge *(C. nebrascensis)*
½ lb./A	Small-fruit bulrush *(Scirpus microcarpus)*

If available, we would definitely seed ½ pound or more of *Polygonum amphibium* or *P. coccineum.*

A dormant fall broadcast seeding, when water levels are low and a lot of ground surface is exposed, is prescribed. If a drill is used, seed should be placed near or at the ground surface.

Saturated Wetlands

Saturated wetlands are a major hydrologic zone in Reach A, with about 11.6 acres, or possibly more if shallow inundated wetlands are not created. In this zone, soils usually are saturated near the ground surface for two or more weeks during the growing season, but usually not inundated. At times, soils will be saturated only within one foot of the ground surface, and less frequently shallowly inundated. Probably none of the noxious weeds are much of a threat here, but there may be a pronounced tendency for *Agrostis stolonifera* to dominate fertile soils. Off streambank, our main objection to this species is competitive dominance limiting diversity. Along the streambank, it is a poor stabilizer because of its shallow root system.

Herbaceous Seed Mix, All Soils

Our basic strategy apart from willow clusters calls for broadcast seeding tufted hairgrass and fowlbluegrass along with some forbs (including legumes) and a lesser amount of red fescue (*Festuca rubra*). Fowl bluegrass is the foremost candidate to act as a nurse crop because it is suited to the site but not expected to provide stiff competition with the species plugged. This bluegrass is rather widely if weakly adapted; compared to sedges and rushes, the grasses of riparian shrub communities are generalists (Goodrich, 1991). If *Poa palustris* is more competitive than anticipated, its use downstream will be curtailed. Although legumes are not expected to persist unless the site is drier than expected, they may promote nitrogen fixation in the short run. No clovers have so far proven strongly competitive in the floodplain. Baltic rush is more competitive and germination of 90% has been reported (Hoag, 1998, pers. comm.). We are unaware of the establishment dynamic of this species from seed, but the tiny seed size hints at weak establishment and it will be difficult to distribute the seed. How well it establishes in this mix will determine its use in downstream reaches. Broadcasting probably will be most practical, but seeding method is not limited in this prescription. A dormant fall seeding is prescribed. A sterile hybrid may be used for temporary stabilization if warranted. Rates are for broadcast or hydroseeding application:

2 lbs./A	fowl bluegrass
3 lbs./A	tufted hairgrass
1 lb./A	red fescue *(Festuca rubra)*
½ lb./A	clustered field sedge *(Carex praegracilis)* or woolly sedge *(Carex lanuginosa)* or both, depending upon availability.
1/4 lb./A	northern reedgrass *(Calamagrostis inexpansa* or *C. stricta)* if available
½ lb./A	slender cinquefoil *(Potentilla gracilis)*
½ lb./A	Baltic rush
1 lb./A	birdsfoot trefoil
½ lb./A	Alsike clover (*Trifolium hybridum*)

Rush, Spike-rush, Sedge Mosaics, Class 2 and 3 Soils

Ideally, we would like to plug all or most saturated wetlands with competitive sedges and rushes, which share the characteristic of being very difficult to establish from seed. This is not possible as a matter of cost, and only 0.8 acres is scheduled for planting, virtually all in Class 2 soils. Since the hydrology of the floodplain will become wetter following removal of the diversion ditch, herbaceous plugs are a better planting option than woody plants. A planting ratio for Class 1 soils is not being used in Reach A. In late spring or early summer following seeding, before seeded species strongly establish, we prescribe planting plugs at an average density of one per 2.25 square feet according to this ratio:

40%	Baltic rush
20%	Nebraska sedge
20%	silverweed*(Potentilla anserina)*
20%	creeping spike-rush *(Eleocharis palustris)*

Shrub Mosaics, All Soils

In this and other hydrologic zones, soils do not determine which willows are planted because our four main willows in Subarea 1 seem to be adapted to a range of textures at least from loamy sands to loams. Patten (1968), working along the Gallatin River, found that soil texture was an important component of willow habitat. Willow growth and cover were positively associated with sand content. Although all soils were sandy (61-84% sand), nonwillow soils usually were sandy loams, whereas many willow community soils had loamy sands.

Saturated wetlands typically are the wettest sites where willows grow to normal size. As sites grade toward shallowly inundated wetlands, willows often become dwarfs. For this reason, willows are not being planted where removal of the diversion ditch is expected to shift the hydrology to an inundated condition. Of the willows along Silver Bow Creek, *Salix boothii* is common and best-adapted to wetlands. *Salix geyeriana* is better represented upstream of the SST OU, apparently not tolerating contaminated sites. It too is tolerant of wetland conditions, although perhaps not quite as wet as *S. boothii*. We recommend a ratio of 2/3s *Salix boothii* and 1/3 *Salix geyeriana*. A planting density of one per square yard is specified. Spring planting of sprigs following fall seeding of grasses is the temporal strategy.

The general seed mix for saturated wetlands must be modified for shrub planting areas. It is similar to the main mix for this hydrologic zone, but we are dropping Baltic rush, which rarely is seen growing under willows and could inhibit shrub establishment via competition. Replacing it is the shade-tolerant rhizomatous grass bluejoint reedgrass, which can be found growing in the open but is much more prevalent under willows or conifers. Broadcasting is prescribed for these areas; the acreage is small.

Herbaceous Seed Mix, Shrub Planting Areas

2 lbs./A	fowl bluegrass
3 lbs./A	bluejoint reedgrass *(Calamagrostis canadensis)*
½ lb./A	northern reedgrass (Calamagrostis *inexpansa* or *C. stricta)* if available

Our hope is that bluejoint reedgrass will persist until the willows form the overstory to which it is suited. Bluejoint reedgrass can be found growing in the open, but it is much more prevalent under willows or conifers. The application area is only about 1/3 acre in Reach A.

Transition Zone (Wetland - Subirrigated Transition Zone)

The transition zone is second in acreage only to saturated wetlands within the floodplain, with about 10.8 acres. A portion, indicated on Figure J1, may occur on Class 1 (very coarse) soil. This area poses a risk to establishing revegetation if warm, dry conditions prevail during the establishment phase, and groundwater elevations simultaneously are low. Thus, the probability that reseeding will be needed is higher than elsewhere within the floodplain. However, once vegetation is established, plant performance is expected to be satisfactory. The other special condition in the transition zone is that the hydrology following diversion ditch removal may make some areas much wetter, possibly drowning transition zone vegetation. For this reason, plantings are located in areas that are expected to retain the same hydrology, or become only a little wetter.

The upper soil at these sites usually is aerated, but frequently saturated from one to two feet below the soil surface for at least two weeks in the growing season. Upland species will tend to invade this hydrologic zone, but in occasional wet years the soil will be saturated to the surface long enough to kill many upland species. In Subarea 1, the average annual fluctuation in groundwater elevation is 1.7 feet, less near the stream, more toward the floodplain margins (Abdo, 1997, pers. comm.). Canada thistle *(Cirsium arvense)*, whitetop *(Cardaria* spp.), and sow thistle *(Sonchus uliginosus)* potentially are serious weeds in this zone. Leaving sites unvegetated for considerable periods is inadvisable. Depending on timing, a preparatory crop may be necessary (annual grass or sterile hybrid). The weed threat also led to identification of a patch mix.

Herbaceous Seed Mix, All Soils

Seeding is expected to establish more permanent plant communities in the transition zone than in wetlands, but plugged species remain superior in erosion prevention and weed exclusion. While the herbaceous seed mix contains more species than most, it is made up of only moderate competitors, so the potential for a rather diverse community exists. It consists of four grasses, none of which are strongly competitive locally. Three legumes are included because it is difficult to predict which is (are) best in the transition zone. Which ones establish and persist will influence seed mixes downstream. The additional forbs have been included purely to provide some visual diversity. The native legume golden banner (*Thermopsis montana)* is a beauty in its own right. In this and all drier hydrologic zones, legumes are important components of seed mixes. Drill seeding probably is feasible most years in this zone, and seed application rates are thus calculated:

1 lb./A	slender wheatgrass *(Agropyron trachycaulum)*
½ lb./A	smooth aster *(Aster laevis)* or western mountain aster (*Aster occidentalis)* or long-leaved aster *(A. ascendens)*, or any combination
2 lbs./A	tufted hairgrass
½ lb./A	Baltic rush
2 lbs./A	meadow barley *(Hordeum brachyantherum)*
1 lb/A	red fescue
½ lb./A	cinquefoil
2 lb./A	false lupine
1 lb./A	birdsfoot trefoil
½ lb./A	red clover
1 lb./A	golden banner

Note: Major revisions of grass nomenclature are occurring, particularly in the Triticeae. The result is that scientific names are more confusing than any time in recent history for those unfamiliar with synonyms. We have retained traditional scientific names.

Mosaic Plantings, All Soils

The strategy is the same as previously discussed: mosaics of variable extent where suitable rhizomatous species are plugged at an 18-inch spacing. About 0.1 acres is being planted. Baltic rush (*Juncus balticus*) is perhaps the best species for the transition zone based on erosion prevention and weed exclusion. It has a broad range of adaption to soil moisture from periodically ponded wetlands to the subirrigated zone, where it would be very difficult to establish however. The approximate ratio will be:

60%	Baltic rush
30%	clustered field sedge
10%	Rocky Mountain iris *(Iris missouriensis)*

Patch Mix

Because this zone is susceptible to weed invasion, we recommend a patch mix in case of initial seeding/planting failure. Of course, remedial action (including replanting) must be predicated on the identified reason for the failure. The prescribed seed mix is not particularly strong in establishing, so care must be taken not to declare failure prematurely. While more aggressive, the species of the patch mix are not expected to spread to adjacent hydrologic zones where revegetation is successful.

3 lbs./A	red fescue
1 lb./A	Kentucky bluegrass (*Poa pratensis*)
1 lb./A	Alsike clover

Herbaceous Seed Mix, Shrub and Aspen Mosaics

This is not a competitive mix and shouldn't hinder shrub establishment. If weeds are a chronic problem in areas where this strategy is applied, the seed mix will be changed.

The seed mix to be broadcast within shrub mosaic (approximately 0.4 acres) areas is:

1.5 lbs./A	slender wheatgrass
2 lbs./A	bluejoint reedgrass
½ lb./A	fireflower *(Epilobium angustifolium)*
1 lb./A	Large-leaved avens *(Geum macrophyllum)*
3 lbs./A	wild lily of the valley *(Smilacina stellata)* (if available at reasonable cost)
½ lb./A	white Dutch clover *(Trifolium repens)*

For willow clusters, the approach is the same as in saturated wetlands: willows are sprigged or seedlings planted in designated shrub mosaic areas. Willow planting density is one per square yard. The same two species of willows that are best-suited for saturated wetlands also are very well-adapted to the transition zone, so the same ratio of sprigs will be planted here: about 2/3s Booth's willow and 1/3 Geyer willow.

Aspen (*Populus tremuloides*) patches will be planted less frequently than shrub mosaics in the postremediation landscape. Aspen is present in Reach A and also along the flanks of the floodplain, often in disturbed areas such as old diggings. It seems to be favored by a coarse rocky or fine-textured substrate which is uncommon in Subarea 1, where sandy substrates predominate. Aspen will be planted on a six-foot grid (1200/acre) with 10 cubic inch seedlings. Transplanting suckers is proscribed because they typically have low survival rates.

Subirrigated and Upland Zones

The subirrigated zone comprises about 7.1 acres, most of which is located in uppermost Reach A, and the rest in the lower quarter or as a narrow band along the periphery of the floodplain. Subirrigated soils are Class 2. About 4.1 acres of uplands will have Class 2 soils, mostly occurring along the edge of the floodplain. The largest single revegetation habitat type in Reach A is uplands with a weedy seed bank, soil texture unknown but tending to be coarse; this comprises about49.7 acres. The repository is another upland class of about 7.5 acres. There are also small upland areas associated with the outer diversion ditch banks and permanent sediment pond banks.

Sandy loams with less than about 10% clay and coarser textures will limit revegetation success in the subirrigated zone and uplands. Within the floodplain, Class 2 and 3 soils are being used in these hydrologic zones. Outside the floodplain, there is a rather large area consisting of BA 10 and areas disturbed by haul roads, ditch construction, and a staging area where soil properties have not been determined, but coarse textures are prevalent. Therefore, seed mixes are needed for soil textures ranging from loamy sands to loams.

For most herbs, the subirrigated zone and uplands are equivalent sites, so they will receive the same seed mixes. Shrubs and trees have been prescribed for the subirrigated zone only, because they have a much greater likelihood of successfully establishing and prospering there. Once they tap the capillary fringe, they are likely to weather drought, whereas woody plant establishment will be difficult in uplands. In decently vegetated uplands, there will be scant soil moisture replenishment below the plant root zone of grasses and forbs.

Rates are for drill seeding. Slopes are expected to be gentle.

Class 2 and 3 Soil Seed Mix

We have a seed mix tailored to Class 3 soils, but the acreage in Reach A is small, so for this reach all soils other than Class 1 are being treated the same. Long-term, sheep fescue (*Festuca ovina*) and to some extent basin wildrye (*Elymus cinereus*) are going to be the main grasses, with the two rhizomatous grasses playing subordinate roles. Big bluegrass (*Poa ampla*) and slender wheatgrass (*Agropyron dasystachyum*) are expected to establish strongly and help exclude weeds and control erosion while the fescue develops. Black medic (*Medicago lupulina*) was chosen over sweetclover (both are legumes) because it is less conspicuous, doesn't lend such a weedy appearance to revegetation, and it is less competitive. Alfalfa (*M. sativa*) was included at a low rate because black medic hasn't been tested locally and it is an annual. Cudweed sagewort (*Artemisia ludoviciana*) and American vetch (*Vicia americana*) are native forbs that can contribute to nitrogen fixation.

1.5 lbs./A	Pryor thickspike wheatgrass *(Elymus lanceolatus)*
3 lbs./A	Covar sheep fescue
1 lb./A	Magnar or Trailhead Great Basin wildrye *(Elymus cinereus)*
3/4 lb/A	Sherman big bluegrass
½ lb./A	Reubens Canada bluegrass *(Poa compressa)*
1/4 lb./A	white yarrow *(Achillea millefolium)*
1/4 lb./A	Cudweed or prairie sagewort *(Artemisia ludoviciana)*
½ lb./A	black medic
1 lb./A	American vetch *(Vicia americana)*
½ lb./A	alfalfa

Included in the upland/subirrigated area will be a two-acre test of Russian wildrye (*Elymus junceus*) in conjunction with alfalfa. The best-known weed-excluding treatment in Butte is to bring the organic matter content of the upper six inches of soil to approximately 1% using compost and seed only Bozoisky Russian wildrye at five pounds per acre. We would like to know if Russian wildrye can be established with alfalfa, thereby reducing the need for organic supplement. If successful, these species can play a role at weed vector areas such as trailheads. If successful, use of this mix will be limited because both species are introduced and strongly limit diversity.

Weedy Soil Seed Bank, Class 1 Soil Seed Mix

These sites have the coarsest soils and highest risk for weed infestation.

The upland/subirrigated seed mix for Class 1 soils consists only of grasses, since blanket herbicide application will be necessary approximately two years after planting. This seed mix combines strong-establishing early competitors (*Poa ampla, Agropyron trachycaulum*) with enduring, reproducing species that also are strong competitors (*Festuca ovina, Elymus cinereus*). Canada bluegrass (*Poa compressa*) has proven itself on some of the worst sites around Butte, is metal-tolerant, and spreads quickly in areas receiving supplemental moisture. Based on expense, compost is not being applied except in a two-acre test area. Costs and benefits will be evaluated relative to the use of compost downstream. Two light applications of urea each year will be applied for approximately five years.

½ lb/A Sherman Big bluegrass
1.5 lbs./A Pryor slender wheatgrass
3 lbs./A Covar sheep fescue
1 lb./A Canada bluegrass
3 lbs./A Magnar or Trailhead Great Basin wildrye

Repository and Patch Seed Mix

Plant communities propagated above repositories must be effective in utilizing soil moisture so that it doesn't percolate into and through contaminated materials. Four factors are important: 1) full occupancy of the site by plants, 2) nitrogen availability, 3) a range of timings of maximum photosynthesis, and 4) complementary root depths. All four species in the seed mix are easily established in a firm seedbed. Nitrogen fertilization can lead not only to increased plant vigor and growth but also to more rapid soil moisture depletion. In this prescription, alfalfa/*Rhizobium* provide nitrogen fixation which is superior in many respects to mineral fertilization. Citing four authors, Ryerson and Taylor (1974) concluded that higher efficiency of soil moisture use and moisture withdrawal to a greater depth usually prevent nitrogen leaching through the soil profile in the 10-14 inch precipitation zone. Unless recharged by fall rains, fertilized plots in eastern Montana rangelands entered the winter months with considerably lower soil moisture content than nonfertilized plots, indicating that nitrogen fertilization can increase the amount of precipitation that is used for plant growth. Yields indicated almost complete carry-over of unused nitrogen fertilizer from drought years (Wight, 1974), suggesting minimal leaching of soluble nitrates. If negatively charged nitrate ions don't leach, it is likely that little if any water percolates through the rooting zone. A range of seasonality of plant growth and rooting depths also contributes to quick utilization of soil moisture throughout the growing season.

Our prescription for repositories calls for compost applied at a rate that provides 2% organic matter in the upper six inches of soil, VAM inoculation, and alfalfa seed inoculation. It is possible to apply properly selected compost at this rate without impairing alfalfa/*Rhizobium* establishment. Alfalfa develops later in the growing season than cool-season grasses and roots deeper than grasses. Sheep fescue is arguably the most successful revegetation grass in the Butte area and has weed-excluding abilities. Canada bluegrass is well-

adapted to contaminated and noncontaminated sites around Butte, responds well to fertilizer, and as a rhizomatous grass complements sheep fescue. Slender wheatgrass is included because sheep fescue establishes rather slowly, and slender wheatgrass establishes strongly but doesn't persist in uplands; it is well-suited to loamy soils.

This seed mix would be a fine patch mix and its use in that capacity is authorized. As usual, the cause of revegetation failures will dictate remedial measures. Where small areas don't revegetate or where killing noxious weeds leaves bare soil, some minor scarification followed by seeding a patch mix is advised.

2 lbs./A Pryor slender wheatgrass
3 lbs./A Covar sheep fescue
1 lb./A Canada bluegrass
2 lbs./A Ladak alfalfa

Ditch Bank Seed Mix

This is a temporary mix for the outer banks of the diversion ditch where a prevalence of non-native species is not a concern. Objectives are weed and erosion control. Rates are for broadcasting application.

2 lb./A Ruebens Canada bluegrass
10 lbs./A Ephraim *Agropyron cristatum* crested wheatgrass
2 lbs./A Ladak alfalfa

Sediment Basin Seed Mixes

Sediment basins in Reach A have three types of sites: embankments, bottoms, and nearby gentle uplands, including excess material stockpiles and temporary topsoil stockpiles. While disparate sites call for different prescriptions, the acreages are small, making three revegetation treatments impractical.

The steep banks (2:1 and 3:1) dictate that the focus should be on erosion control and secondarily weed control. Due to high erosion potential, quick-establishing species are needed. Because of the small acreage, using introduced species should not be a limiting factor. Therefore, the seed mix listed for ditch banks also is prescribed here for all areas other than the bottom of sediment ponds, where smooth brome and birdsfoot trefoil will be planted. This grass does well if not long inundated, establishes easily, and is very aggressive and competitive with weeds. Smooth brome also is adapted to sediment deposition. Birdsfoot trefoil is one of the most water-tolerant legumes. The rates will be four pounds of pure live smooth brome seed and two pounds of birdsfoot trefoil seed per acre. "Lincoln" would be one acceptable variety of the smooth brome.

Shrub and Tree Plantings – Subirrigated Zone Only

Shrubs and trees should be planted in the subirrigated zone in early spring following the fall seeding of herbs. Failing that, scalping of herbs to reduce competition will be necessary. Slow-release fertilizer pellets are recommended at the bottom of the planting holes, which are best augered.

Shrub Cluster Mosaics

Most phreatophytes tend to develop shallow lateral root systems that are unable to grow to extended depths. As a rule of thumb, the chance of establishing phreatophytes is poor where groundwater levels fall more than one meter below the soil surface. Where groundwater is deeper, using irrigation to induce root growth is

questionably effective. However, augering to groundwater and planting large cuttings can work (Briggs and others, 1995).

Two types of shrub clusters are proposed. The most common one, to be planted along sloped banks that generally separate the floodplain from uplands, will consist only of *Salix exigua*. Investigations of plant communities, soils, and hydrology along Silver Bow Creek and nearby environs revealed that *S. exigua* is often found where the ground surface is more than one meter above the seasonal water table. Patten (1968) likewise found that this species apparently can colonize sites farther from the river than other willows and indeed reached its best development in this area. *Salix exigua* has been successfully established from sprigs in the Crackerville area east of I-90 where the seasonal water table is deep, but a perched, seasonal water table was present at about 1.3 meters. Plant competition at this site was minimal and the soil surface was contaminated. Deep sprigging of this species requires stout sprigs, two meters long (if available) and as thick as possible. Planting density will be one square meter. Mechanical planters are approved for this application. Sandbar willow plantings should comprise roughly 2/3s of the willow clusters in the transition zone.

A mix of three shrubs will be planted in the remaining 1/3 of shrub clusters in the subirrigated zone. These clusters will be a combination of *Salix bebbiana* established by deep sprigging or as seedlings, and *Ribes aureum* and *Rosa woodsii* (nonphreatophytes) planted as tubelings. All three will be planted together in early spring — the tubelings will depend on precipitation until their roots reach the capillary fringe, and in dry years a lot of mortality could occur. Combined planting density will be one per square yard.

Competition with herbs must be minimized. No special seed mix is recommended, but a reduced application rate, or broadcasting rather than drilling, is recommended. If herbs are well-established at the time of shrub planting, scalping may aid establishment. This is especially important for shrub seedlings.

Deciduous Tree Clusters

The Silver Bow floodplain appears to be inhospitable to cottonwoods (*Populus* sp.), but no better native tree candidate is available. Brunsfeld and Johnson (1985) observed that cottonwoods are associated with coarser-textured soils than willows. Balsam poplar *(Populus balsamifera)* probably can be grown in portions of the floodplain and will persist, although natural reproduction will be limited. Our initial strategy is to plant seedlings on ten-foot spacings, preferably in coarse substrates. If the seedlings don't survive, giant sprigs may be tried. Hoag (1991) found that long cuttings with large diameters planted into the midsummer water table gave the highest success rate; small power augers were the most effective planting method. Diameters greater than one and a half inches were preferred, and diameters of three to five inches had even better success. Eighteen-inch-long cuttings were much too short, and cuttings three or four meters long were most successful. Pounding, even with protective caps, shattered the tops of cuttings and this practice has proven ineffective (Carlson and others, 1991).

As Hoag (1991) said, if native cottonwoods are not found in the vicinity, planting them may not be a good option. Easier to establish and better-suited to Subarea 1 is brittle willow *(Salix fragilis)*, a tree-like willow growing along Blacktail Creek in Butte and on some small tributaries to Reach A. We initially planned to plant this tree-like willow, but decided against rushing to promote another nonnative species.

Snowberry (*Symphoricarpos*) and rose (*Rosa*) are frequent associates of cottonwoods. Spring planting from nursery stock at a rate of one per square yard is prescribed prior to strong herb establishment. Snowberry is better suited to Class 3 soils, whereas rose is expected to perform best on Class 2 soils.

Seeding and Planting Acreages

While maps are still undergoing revision, Table J-1 shows approximate seeding and planting acreages anticipated for Reach A.

J1.3 Seeding and Planting Practices

Seeding

There is no need to review drill seeding, by far the most common method of establishing herbs from seed. Professionals will have equipment to deal with large, small, and trashy seed, possibly including a legume box and/or pull-type broadcast seeder to complement drill seeding of heavy seed. Particulars must match planting conditions.

Drill seeding, so effective in uplands, generally is inappropriate for wetlands. Not only will wet substrates limit equipment use, but few are the wetland seeds that benefit from a soil covering or even much of a water covering. For saturated wetlands and the transition zone when wet, broadcasting (including hydroseeding without mulching) is prescribed. Broadcasting is most effective for species with light seed. A firm seedbed is necessary, particularly in coarse substrates. If conditions allow drill seeding heavy seed and broadcasting light seed, so much the better. There is no point in seeding open water as the seed accumulates at land margins on the leeward side.

Seed rates in this plan are considerably lower than are often prescribed. Application rates of 20-30 lbs./A are common – even for drilled seed. In many cases, heavy seed rates are prescribed as a sort of insurance: no matter how poorly seed is applied, some seedlings will make it above the ground. Heavy seeding often gives an appearance of solid rows of green (composed of thousands of individual plants), which looks impressive.

In the long run, benefits of heavy seeding are few if any. Eventually, a site will support a certain number of plants of a certain type regardless of how many are planted, with fertility playing a big role. A couple of herb seedlings per square foot is adequate (see Performance Standards). In the short run, the question is whether heavy seed rates perform better in erosion and weed control. To a degree they may. Mueggler and Blaisdell (1955) seeded crested wheatgrass at 2, 4, 8, 12, and 24 pounds of seed per acre. Differences were obvious the first three years, with fewer plants per foot of drill row for the two- and four-pound seedings. By the sixth year, all stands were producing a like amount of herbage regardless of the initial seeding rate. While early erosion control may benefit from heavy seeding in some circumstances, a gully-washer will strip off topsoil no matter how many seedlings are present, and no amount of desired seed will compensate for a weedy seed bed.

TABLE J-1
SUMMARY OF SEEDING AND PLANTING ACREAGES
Reach A (Subarea 1) - SSTOU Remedial Design[1]

Revegetation Zone	Plugs	Acre	Shrubs[2]	Acre	Trees	Acre	Seeding	Acre	Com-post	VAM (3)
Deep Water Wetland	Beaked, water, and	0.10	--	--	--	--	Margins only; bulrushes and sedges	<0.1	No	No
Shallow Inundated Wetland	Beaked and water sedge, water smartweed, small-		--	--	--	--	Fowl bluegrass, smallfruit bulrush, Baltic rush, tufted hairgrass, American mannagrass, sedges, northern bluejoint.	1.1	No	No
Saturated Wetland	Baltic rush, silverweed, spike-rush, Nebraska sedge.	0.80	Booth's and Geyer's willows.	0.60	--	--	Fowl bluegrass, tufted hairgrass, Baltic rush, red fescue, 2 legumes.	11.6	No	No
Transition Zone	Baltic rush, clustered field sedge, iris.	0.10	Booth's and Geyer's willows.		Aspen	0.10	tufted hairgrass, Baltic rush, meadow foxtail, legumes	10.8	No	Yes
Subirrigated	--	--	Sandbar willow, Bebb's willow with Wood's rose and golden current.	0.1 0.04	Cottonwood with snowberry	0.15	See upland/subirrigated below	--	--	--
Uplands/ Subirrigated - Class 2 and 3 Soils	--	--	--	--	--	--				
Shrub areas							Sheep fescue, thickspike wheatgrass, basin wildrye, Canada bluegrass, forbs, & legumes.	8.5	No	Yes
Test							Slender wheatgrass, lily of valley, bluejoint, white clover.	0.5	No	Yes
							Russian wildrye and alfalfa	2.0	No	Yes
Uplands - weedy seed bank	--	--	--	--	--	--	Sheep fescue, basin wildrye, slender wheatgrass, Canada bluegrass.	47.7	No	Yes
Same, compost test							Same	2.0	Yes	Yes
	--	--	--	--	--	--				
	--	--	--	--	--	--				
Mine Waste Relocation Repository	--	--	--	--	--	--	Sheep fescue, Canada bluegrass, alfalfa, slender wheatgrass	7.5	Yes	Yes
Sediment Basin sides	--	--	--	--	--	--	Crested wheatgrass, alfalfa, Canada bluegrass	3.4	No	No
Sediment Basin bottom	--	--	--	--	--	--	smooth brome	0.2	No	No
Total Acreages	**Plugs**	**0.96**	**Shrubs**	**0.71**	**Trees**	**0.23**	**Seedings**	**69.8**	**13.0**	**53.4**

Notes:
(1) - Acreage summary calculated from digitized areas by Montana Natural Resouce Information System as shown on Sheet N1 - PFDR; total disturbed acreage 70.8
(2) - A special seed mix will be used in all shrub planting areas that includes *Poa palustris, Calamagrostis canadensis*, and *Calamagrastis stricta*
(3) - VAM = vesicular-arbuscular mycorrhizae

The downside is that the temporal and competitive considerations that guided selection of the amount of each species in a mix can be negated by seeding heavy rates. For example, in subirrigated and upland zones, slender wheatgrass and big bluegrass are prescribed in rather small amounts because they establish strongly and will help control erosion and weed invasion. At the same time, the quantity prescribed is expected not to interfere with more enduring but weaker-establishing species such as basin wildrye and sheep fescue. However, what works when seven total pounds of seed are applied to an acre does not necessarily work when 21 pounds of seed are applied, and three times as much of the strong establisher is seeded. No matter that three times the amount of the weak-establishing species also are seeded, the point is that a high density of the strong-establishing but ultimately less-suited species is present and will strongly influence species composition. We will adjust future seed rates based on experience gained with the species and rates prescribed.

Some seeded species develop slowly over the course of a few years, and caution must be exercised before prior to taking unneeded corrective measures (e.g., excessive fertilizing).

Planting Shrubs

Platts and others (1987) noted that the dense and frequently storied assembly of many plant species is required to maintain riparian site stability, and that reestablishing woody plants is often the most critical component of this endeavor. Local genotypes must be used unless unavailable. The best course is to hire experienced planters, probably from the nursery supplying the shrubs.

Some species are so difficult to establish from seed that seeding is unlikely to work in wetlands lacking water level control. Shrub and tree establishment from seed, for example, is episodic in unregulated wetlands for two reasons. First is the exacting moisture requirements. Willow seeds are not banked in the soil; seeds of sandbar and whiplash willow (*Salix lasiandra*) remain viable in the soil only for a few days or weeks (Brinkman, 1974). For willows and allied species to establish from seed, the substrate surface must remain wet for several weeks following seed dispersal. The soil must be wet to within a few inches of the surface for seedlings to survive. However, persistent inundation prevents root anchoring first, and later leads to stunted roots, then drowning. Thus, it is the exacting upper soil moisture requirements that make willow establishment from seed infrequent in nature. When it does happen, it explains why willow and cottonwood stands usually are even-aged.

The second factor that limits establishment is competition for resources. To continue the willow example, it is competition between life-forms (i.e., shrubs and grasses). Competition is a chief cause of mortality of planted shrubs (Kleinman, 1996). The fibrous roots of many grasses suck water and nutrients out of the soil much more effectively than shrub roots. Shrub roots, on the other hand, tend to grow much deeper than grass roots. If moisture and nutrients are present at depth, shrubs can tap into an unexploited resource, but first they must live long enough to develop a deep root system. It is the first few years of a shrub's life where competition with grasses is a major cause of mortality. In revegetation, limiting competition unfortunately can promote weed establishment. Our prescriptions call for noncompetitive seed mixes or light seedings to limit competition between life-forms.

Methods of propagating willows from sprigs are well-known and would hardly merit mention were it not for the considerable number of planting failures along Silver Bow Creek, below the Warm Springs Ponds and farther down the Clark Fork. Sprigging is based upon adventitious rooting, i.e., formation of roots from parts of the plant where roots do not generally arise, such as stems and even leaves. Many species of willow have root primordia throughout the stems, a physiological adaptation to sediment deposition and perhaps coevolution with beavers.

The efficacy of sprigging varies by species. Of those present on Silver Bow Creek, whiplash willow *(Salix lasiandra)* is easiest to sprig, but this species is better-suited to Subarea 4. Brittle willow (*Salix fragilis)*, more tree than shrub, also is easily sprigged. Of the four shrub willows that will be planted in Subarea 1, three are easily sprigged, and Geyer's willow *(S. geyeriana)* is a little more difficult to propagate this way (Platts and others, 1987). Sandbar willow *(Salix exigua)* is no better than others at sprigging, but it is adept at vegetative reproduction from lateral roots. In conjunction with the flexibility of its shoots, this makes it a desirable species for streambanks.

Treatment of sprigs with a rooting hormone (auxin) probably will enhance reproductive success of all species. Auxin concentrations to promote root growth are very low compared to concentrations that promote leaf growth, flowering, etc., and excessive concentrations actually inhibit rooting. Nurseries can provide synthetic hormones for very low cost. Hoag and Sellers (1995) said growth hormones were unnecessary when planting large numbers of sprigs, but the cost is very low and probably it will enhance success when the timing of planting is suboptimal (but not into midsummer).

With regard to sprigging technique, variations abound, but these points come out repeatedly (Hoag, 1993a; 1993b; Hoag and others, 1994; Hoag, 1994):

A. Use dormant cuttings. December to March is the best time to collect in our area. Cut off the apical bud so energy will be directed to lateral buds, including adventitious roots. Cut off all lateral branches flush with the main stem and at least two feet from the top. Store in a dark, cool (24-32° F), moist environment such as a root cellar to maintain dormancy.

B. Cuttings should be from healthy branches/stems that are more than one-year-old but less than 12. Don't collect unsound or diseased stems. Don't use suckers of current year's growth. Paint or mark the top to assure the right end is planted. Dipping the top couple of inches in dilute latex paint prevents excessive water loss and clearly identifies which end should be planted (Hoag, 1994). Cut the lower end at an angle.

C. Soak cuttings for at least two days and less than one week prior to planting. A little auxin in the soaking solution will promote root initiation, but do not soak so long that roots emerge, as the roots are fragile and probably won't survive planting. Butte tap water might not be the best due to high chlorine content. Streamwater is recommended.

D. Cuttings are very susceptible to desiccation after the pre-planting soaking period. They could be transported to the site in drums with water in the bottom foot or two. They cannot be allowed to dry out while carried in the field – this inconvenience can be a problem with planting crews who usually are paid on the basis of individuals planted, not survival.

E. Plant in spring, optimally at the time of flowering, which usually is May here, sometimes a little earlier. Sprigging after midsummer probably is futile.

F. Sprigs must be planted to the depth of summer groundwater, except possibly for sandbar willow which has been observed to establish successfully when planted above a partially perched seasonal water table where plant competition from other species was minimal. Sprigs should be in contact with groundwater but not completely submerged year-round. Drought and drowning both are considerations. Groundwater fluctuations in Subarea 1 range from a little more than one foot to more than two feet, with an average fluctuation of 1.7 feet (Abdo, 1997, pers. comm.). For spring planting, willow sprigs must be planted at least one foot into groundwater. Minimum sprig length is three feet, but in any case sprigs must reach the summer groundwater table and have at least 1/3 (but not more than half) of the stem aboveground. A rule of thumb

is 2/3s below, 1/3 above, and also three buds aboveground. At some sites this will call for sprigs two meters long, which is another reason that seedlings have been approved for some plantings. The amount aboveground should overtop herbs including weeds.

Large diameter sprigs have a better chance of surviving due to greater stored carbohydrates. Size varies by species. Sandbar willow typically has slender stems. Diameters exceeding one inch are common in the old wolfy plants now present, but less common in younger, healthier stands. Sprigs of this species must have a minimum diameter of 0.6 inch and be one meter long. Other willow species (e.g., *Booth's willow [Salix boothii* a]nd Geyer's willow) must be larger, with a minimum diameter of 3/4 at the narrow end, and also one meter long for Booth's and Geyer's willow. Hoag and others (1994) recommend and average diameter 1.5 inches or larger if possible. Sprigs planted in drier hydrologic zones must be larger than sprigs planted in wet ones. In Subarea 1, the need for large sprigs would be greatest in the subirrigated zone where Bebb's willow will be planted. Bebb's willow springs might have to be two-meters long, or seedlings may be substituted. Sandbar willow planted in the subirrigated zone must reach the seasonal, but not the summer, water table, and plant competition with herbs must be minimal.

G. Intimate contact with the soil is a critical element in establishment. Along the streambank proper, sticking them in moist soil is preferred. Where spud bars or augers are used, the willow can't have adjacent air pockets. Thus, the planting implement should be of smaller diameter than the average sprig, and it should not be worked to create a larger hole. As the size of sprigs and depth to groundwater increases, a power auger becomes more appropriate, but the size of the bit should not greatly exceed stem diameters, and tamping is necessary. "The process is very similar to planting a fencepost" (Hoag, 1994).

Shrubs planted as containerized stock include willows off the streambank, aspen, cottonwoods, golden currant, Wood's rose, and snowberry. For shrub and tree seedlings, ectomycorrhizal inoculation is required if available from the selected nursery. Any nursery can provide handouts on how to plant seedlings and small saplings; it is not a job for the uncaring.

H. Aside from dessication in transport and improper planting techniques, competition with previously established herbs is usually the main cause of mortality (Kleinman, 1996). Woody plants must be planted deep enough to limit competition with the fibrous-rooted grasses – willow plantings have been prescribed for hydrologic zones where groundwater will be available in the root zone once they establish. Conroy and Svejcar (1991) found that ground cover (as an index of plant competition) was related more to growth rate than willow survival, but we are looking for vigorous establishment as well as survival. They also found that planting location was the best indicator of survival, but they planted all willow sprigs to a depth of 30 cm, irrespective of topographic position.

To counter competition between woody plantings and herbs and to prevent mice girdling woody plants, Carlson and others (1991) recommended mulching with gravel or bark around plantings rather than ground cover seeding. This practice is of questionable practicality for when thousands of willows are being planted, and won't be used unless the problem is more severe than anticipated. Where practical, the seed rate (herbaceous mix) can be cut in half in shrub planting areas, or these sites can be avoided in drill seeding and then broadcast seeded at a reduced rate. Planting woody plants in advance of herbs may be an option in some cases for shrub establishment if not planting logistics, although it limits herbaceous seedings to broadcast or hydroseeding. Where vegetation has established, scalping the ground around the shrub for about a half-meter promotes establishment where rhizomatous species are not prevalent. It is, however, labor-intensive.

I. The effectiveness of fertilization in promoting the willow growth has been well-documented in Scandinavian countries where willows are grown as an energy crop. Walker and Chapin (1986) found that

fertilizing a silt loam resulted in an eightfold increase in total willow biomass. Streambank willows will benefit from the nutrient-rich water of Silver Bow Creek. Away from the streambank, placing slow-release fertilizer pellets in the bottom of willow planting holes is prescribed. This is a competition strategy.

J. Hoag (1993a) said that anticipating 10% mortality is a good rule of thumb. Local experiments using few, if any, of the practices outlined above have achieved less than 10% success. Second-year mortality of sprigs planted along the upper Clark Fork (Clark Fork River Stabilization Pilot Study) was about two-thirds. In contrast, containerized seedlings (one gallon size) had about 96% survival. Therefore, seedlings are authorized for nonstreambank shrub and tree plantings. For willows and smaller shrubs, 10 cubic inch containerized seedlings will be used. For aspen and cottonwoods, one-gallon containerized seedlings will be planted. Densities specified in the performance standards must be achieved in the third year following planting.

Planting Wetland Herbs

Establishing some wetland and transition zone herbs is expected to be difficult from seed, and vegetative propagation prevails in nature with propagules transported by stream current. Bitterroot Restoration (Ballek, 1996) made this assessment:

> Attempting to revegetate wetlands by seeding can be expensive and unproductive. Most wetland plant seed is costly and the supply is limited. Seeding attempts often fail because of poor germination. For germination to occur, seed must be sown under conditions of appropriate moisture, temperature, soil conditions and seed viability. These conditions are very difficult to control in a restoration project. Most wetland plant seed requires pretreatment and untreated seed may have low or no germination. Many wetland species also require light for germination and the applications of mulch prevents the exposure to light.

Few easily seeded species can match the degree of erosion resistance provided by native sedges, small-fruit bulrush, and Baltic rush that will be planted in the appropriate hydrologic zones and soils. These species are predominantly rhizomatous and are best propagated from plugs. Plugs are portions of mature plants including shoots, crowns, and roots. One mature plant can be dissected into many plugs. Plugs are recommended for some wetlands and the transition zone, and they must be planted into moist soil. The best time to plant is when it's hot and moist (Hoag and others, 1994), which is June - July here. Our short frost-free season (60-80 days) argues against planting later than early August, a month as warm as July but often with lower humidity.

Vegetative propagation predominates, so sedges can thrive if divided; true seedlings are uncommon in sedge colonies. Their rhizomes are similar to leaf-bearing, upright stems but generally have reduced, leaf-like scales at the internodes. Many sedges have the ability to reabsorb nutrients from dying shoots. Many sedges thrive in infertile soils (low in fixed nitrogen, phosphorus, and potassium). Harvesting transplant materials may best be done in late fall because the concentration of stored nutrients in rhizomes is then highest. Spring harvest risks disturbing early root growth (Groff, 1992).

Hoag (1998, pers. comm.) recommended wild sources, if available, because of the beneficial aspects of soil microbe inoculant. If that is impractical, a portion of wild plugs among greenhouse plugs will provide some inoculant. The final alternative is to drop some soil from a native wetland into the hole when planting greenhouse plugs. Although greenhouse plants consistently spread more quickly (from rhizomes) the first year or two, after several years wild transplants are equally effective in vegetating an area (Hoag and Sellers, 1995).

J1.4 Plant Litter Management

In cold environments, decomposition of dead plant material is a major restriction on nutrient mobility. Decomposition is limited by low temperatures, drying of surface materials, low decomposer populations, and high C:N:P ratios. The decline in vigor of revegetation often is matched by the accumulation of dead plant material on the soil surface. Successful strategies should include using species that develop an organic matter cycle primarily belowground. Species such as crested wheatgrass, which expend a disproportionate amount of resources generating shoot material, fare poorly in cold climates (Ziemkiewicz and Takyi, 1990).

Our goal is to establish plant communities that cycle nutrients more effectively in the belowground compartment, but the initial flush of aboveground growth that usually characterizes successful revegetation still can tie up important nutrients in plant litter. Depending on the accumulation of standing and surface litter, mowing and harrowing three to five years following planting may benefit nutrient cycling by putting standing and surface litter into intimate contact with the soil. The need for this cannot be predicted, but it may be needed around the third to fifth year following planting, and it is approved where warranted.

J1.5 Erosion Control

Away from streambanks, the risk of water erosion is greatest from the construction phase until perennial plants are well-established. The potential for mass soil movement is great until midsummer the year following construction, at which point it begins to diminish noticeably. By year three, plant and litter cover will provide effective erosion resistance. Mulching as soon as practicable provides a degree of protection, a preparatory crop more so. A sterile grass hybrid is approved for areas where planting the permanent mix is delayed.

In general, there is a trade-off between quick-establishing, erosion-limiting species and those species best-adapted for the long run. Our strategies favor the long-term view, to some degree, over short-term protection, although not to the extent that erosion and weed control objectives are overlooked. We place the ecological emphasis on the long term, finding the risk of occasional more or less catastrophic failure more acceptable than the virtual assurance of widespread unsatisfactory revegetation in a decade or two. The satisfactory appearance of herbaceous vegetation even after five years can belie its long-term success (Prodgers, 1998a).

J1.6 Weed Control Measures

Noxious weeds can dominate for the foreseeable future, stifling healthy vegetational changes, limiting diversity, and impairing desired functions and uses. Agronomic practices that promote vigorous establishment of desired, planted species also provide a fine habitat for weeds. Many native plants have slow-growing seedlings that cannot compete with weeds in an agronomic setting (Meyer and Kitchen, 1995). Plants adapted to drought (upland native perennials) usually sacrifice growth rates (Jones, 1983), which may leave them at a competitive disadvantage with weeds that typically weather droughts in a protected state.

The hydrologic and geomorphic heterogeneity of riparian areas coupled with frequent disturbance makes them especially subject to weed invasions (Planty-Tabacchi and others, 1996). As the floodplain develops or the corridor structure is altered, the cross-floodplain links to uplands promote the recruitment of new species. Riparian systems may be easily invaded by "external" species following changes in landscape structure, and since floodplains typically contain sites suitable for nonriparian species, nearby nonriparian taxa become established (Tabacchi and others, 1996). The abundance of serious weeds such as butter-and-eggs and spotted knapweed near Silver Bow Creek promises that weeds will colonize the floodplain, particularly when open sites are available.

Some of the following weed control measures were discussed briefly toward the end of 3.12.4:

1. Prevention. Having essentially weed-free substrates within the floodplain is a benefit. Measures to limit weed seed introduction into the floodplain during construction include chemical control of weeds in areas where vehicles and equipment will operate. Further, the construction contractor is responsible for maintaining weed-free staging areas including equipment-washing areas, and limiting vehicular travel once planting substrates are in place. The contractor is expected to make serious efforts to limit the spread of weed seeds into the floodplain, and the Owner's representative will enforce weed limiting measures throughout construction.

2. Clean Substrates. How prevalent noxious weeds become is in part determined by temporal factors. It is important that substrates be as weed-free as possible at the time of planting. This condition is met by most coversoil material and (previously buried) in situ soils. At repositories, where compost will be incorporated into the upper coversoil, stockpiled weedy topsoil will be buried at least one foot below the ground surface. This is more practical than the alternatives: tillage and fumigation. The soil tillage approach requires too much time, and the soil fumigation approach is too expensive (on the order of $600/acre; Bluhm, 1992). Fumigation also kills desirable soil organisms, reducing the potential advantages, and application may be limited in riparian areas.

3. Plant Competition. The more fully desired species utilize resources, both spatially and temporally, the less likely infestation will develop. Where revegetation can be established with few noxious weeds, and where weeds are chemically controlled before they become abundant, plant competition by planted species is expected to limit weed abundance, particularly in the long run. Species that have been shown to dramatically limit weed abundance locally when successfully established include Russian wildrye, sheep fescue, basin wildrye, and alfalfa. (Prodgers, 1998a). Our strategy is to establish habitat-adapted species considering temporal developments and promote their vigor in the early years by establishing or accelerating nutrient cycling. Russian wildrye, the best weed-excluding species found so far on the Butte Hill, is being tested in conjunction with alfalfa and may be prescribed for special weed vector areas, such as trailheads.

4. Site Quality. In the floodplain, establishing persistent, relatively weed-free plant communities will be promoted by using soils of texture no coarser than sandy loams with approximately 10% clay content or more. Poor soils lead to impaired plant performance, especially in droughty years or where establishment was poor, again often related to dry conditions. Unoccupied microsites then are colonized by weeds in more favorable years. Plant nutrition strategies will provide adequate macronutrients for good plant performance. When seeding, nitrogen fertilizer should be applied along drill rows and not between the rows. Despite initial flush of weeds that sometimes follow inorganic fertilization, strategic placement of fertilizer may favor desired (seeded/planted) species over weeds, both pioneers and noxious.

5. Mycorrhizae. We count VAM inoculation among weed control measures. Most weeds have an abundance of root hairs which give them an advantage over may desirable perennials in nutrient uptake. Inoculating with VAM should give desired species a competitive boost in relation to weeds. (VAM is discussed later n this appendix.)

6. Clean Compost. Where needed, compost has been selected rather than stockyard manure because uncomposted manure brings with it the risk of putting weed seed into the seedbed, including weeds that are not normally problems in this portion of Silver Bow County. Plant pathogens also can establish from raw manure. The elevated nitrate levels found in manure favor weedy species and

also inhibit nitrogen fixation and beneficial soil organisms. In properly prepared compost, plants seeds are killed in a few days by relatively high temperatures.

Unfortunately, most upland sites including borrow areas and sites that will be used as haul roads and staging areas have heavy weedy seed banks in the topsoil and soils may be more coarse than desired. Noxious weeds will establish with desirable species if not earlier. Special seedings and management practices have been developed for weedy substrates. In general, the species that have shown weed-excluding tendencies once well established are not strong establishers. These areas will have the greatest need for chemical control, and probably entire areas will require herbicide application. No forbs, including legumes, will be planted in these areas. Because nitrogen fixation is not an option and organic amendment is so costly, supplemental nitrogen fertilization has been prescribed for these areas except for two two-acre test areas where compost will be incorporated into the soil. Plant performance will be evaluated with/without compost, and advantages evaluated relative to cost. The outcome will determine how much compost is used in subsequent reaches.

Elsewhere where weeds establish, grubbing or selective chemical weed control will be used to nip weed invasions until revegetation is well-established. Grubbing or careful application of herbicides from backpack applicators or applicator hoses attached to tankers should suffice where weed seed is absent at the inception, again being most effective in the establishment year. Prompt treatment of incipient infestation is at least as important as the type/rate of treatment. Leafy spurge, for example, can be chemically controlled in its establishment year, but it subsequently becomes very difficult to control. Sprayed areas also will be seeded with a "patch mix."

Only herbicides approved (on the label) for riparian areas can be used in wetlands, subirrigated sites, and the transition zone that bridges them. These include 2,4-D, fosamine, glyphosphate, and triclopyr. Use of a wick applicator will limit ground contamination, so it is very suitable for riparian application. Other persistent or especially leachable herbicides can be used only where they will not reach water.

Except for the weedy seed bank area, revegetation strategies for well-aerated sites rely on nitrogen fixation. Any kind of blanket herbicide application will kill the legumes, which is one reason early spot herbicide application is critical. If nitrogen fixation is curtailed, still-fertile sites will be open for colonization by new plants, and this is an optimal scenario for weed invasion. To counter this, rhizomatous species have been included in virtually every seeding or planting mix. Vegetative propagation is far quicker and more reliable than reproduction from seed for most desirable perennial species. At least two rhizomatous grasses used in prescriptions respond well to fertilization: thickspike wheatgrass and Canada bluegrass. If heavy weed infestations lead to herbicide application to sites where nitrogen fixation was counted on to establish nitrogen cycling, the relative roles of nitrogen fixation and compost in revegetation will be evaluated relative to future revegetation.

To an extent, infestation of noxious weeds indicates that resources such as soil moisture and nutrients are not being used efficiently some time in the growing season. Simply killing the weeds often leaves the site ripe for reinfestation because weeds are more adept at colonizing new habitats than desirable perennials reproducing from seed, and weed seed usually predominates in the soil seed bank even in nonweedy plant communities (Clark, 1991). Following herbicide application, scratch up the ground surface, plant some seed such as the standard seed mix or patch mix, and rake lightly. If desirable species remain, apply a little fertilizer at the time of planting, recognizing that fertilizer will be most effective if applied between May and July. If the plot of ground is relatively barren when the weeds are killed, postpone applying the fertilizer until desirable species have established, i.e., the next year. If legumes establish, nitrogen fertilization is inappropriate.

Most revegetation requires some manipulation while functional components establish and equilibrate. Chemical weed control is one of these manipulations, along with fertilization and litter management. Long-term, the amount of weeds deemed acceptable in a recreational area depends on the public's perception of weeds. Possibly there is a place for low-maintenance biological control along the floodplain in the long run. The floodplain cannot remain a weed-free oasis with prevailing attitudes and adjacent chronic infestations.

The Weed Control Supervisor for Butte-Silver Bow reviewed this section (Carlson, 1998, pers. comm.). In a nutshell, his comments were: 1) aside from Russian wildrye, he is skeptical of the ability of plants to exclude knapweed, 2) he endorsed the idea of spraying affected areas and nearby areas the year prior to construction, and regretted that it wasn't done in 1997, and 3) he agrees that manure shouldn't be used because it introduces/spreads cheatgrass and whitetop. Mr. Carlson strongly favors early spot treatments of incipient weed invasions. He mentioned that there is some promise of a herbicide that can be used on knapweed in alfalfa stands without killing the alfalfa. It now appears that the County will be involved in streamside weed control. They will work with a plant ecologist to assure that herbicide applications do not target planted species, particularly legumes.

J1.7 Temporal Considerations

Leonard and others (1992) proposed a model of "site progression" for riparian ecosystems that differentiated between secondary plant succession within a given habitat and changes in ecological site resulting largely from fluvial processes. Our temporal planning is of the first type, although by using many species currently found in the floodplain, the recovery process following drastic disruptions will be promoted.

Species that both start and finish strong are uncommon. Ziemkiewicz and Takyi (1990) noted that revegetation in cold regions often appears successful for several years, only to deteriorate as surface cover diminishes and erosion occurs, a phenomenon evident on the Butte Hill. In some cases, the species best-adapted to establishment and early occupancy of agronomically prepared seedbeds are not those best-suited to tight nutrient cycling on substrates modified with the passage of time.

The best revegetation strategies aim at rapid establishment to limit soil erosion and weed invasion and to provide the organic matter or nitrogen fixation for incipient nutrient cycling. At the same time, those species ultimately best-adapted in the long run are established and expected to prosper as the strong starters decline, often following autogenic site modifications. Species that establish well but do not persist can have a place in revegetation strategies if they are teamed with slow-establishing species that perform well in the long run. In this sense, the design incorporates temporal considerations into revegetation planning. An example of this was given for the repository in Section 3.12.4.

A strategy of applying simple seed mixes suited to the particular habitat and considering temporal developments has a far higher likelihood of succeeding than elaborate mixes that attempt to cover a broad range of habitats with no way of predicting which will establish and how community composition will change through time. Combining in a seed mix for application in an agronomic setting those species that are niche specialists with those species that are strong establishers, broadly adapted, and highly competitive only wastes the expensive seed of the niche specialists. As Kuchler (1967, p. 44) pointed out "...a species will find its optimum growth conditions, and indeed its chance for survival, depend not only on the physical and chemical nature of the site but quite as much on the species with which it must compete."

J1.8 Aesthetics and Diversity

Patterns of different physiognomic vegetation types contribute to the attractiveness of landscapes, linking diversity and aesthetics. (In physiognomy, the emphasis rests on the appearance of vegetation, regardless

of its floristic composition.) To the extent that this is achievable within the constraints of matching plants to habitats, controlling weeds, establishing nutrient cycling, etc., we have endeavored to establish a visually pleasing pattern of physiognomic vegetation types. Willows, golden currant, and deciduous and coniferous trees will be interspersed among the prevailing sedge-rush, grass, and grass-forb plant communities. The acreage of woody plantings is small in Reach A because we are experimenting with which species and types of plantings are most successful. Possibly more plantings will be used once the most successful strategies are identified.

In uplands, the potential for landscape diversity is more limited. Grass and grass-forb communities are the only practical alternatives. The potential to establish woody plants is limited, especially given the prevalence of noxious weeds in nearby areas. Establishing shrubs from seed in our region requires strategies that limit competition from other planted grasses and forbs, and this is not an option where noxious weeds are far more likely to establish than desired shrubs.

Diversity is a human concept. Consequently, it can be measured many ways at several scales. One approach is to count the species or broader taxonomic groupings (genera, families) within a habitat, or compare taxonomic similarities/differences to nearby habitats. A complementary approach mathematically evaluates the proportional abundance of species in plant communities. These approaches are more satisfying to botanists and mathematicians than laypersons. The pattern of physiognomic types provides diversity in a way obvious not only to humans but also to wildlife. This is diversity at the landscape level. In reclamation, diversity is best addressed through a variety of habitats, each suitably vegetated (Prodgers and Keck, 1996). Our revegetation plan recognizes four hydrologic zones and three soil/coversoil classes. To portions of these habitat types we have prescribed a variety of seedings and plantings representing several life-forms.

J1.9 Maintenance

Intense precipitation in the establishment phase can wreak havoc with the best-planned and best-implemented revegetation, and weeds can get out of hand if not treated promptly. Evaluating the need for maintenance will begin almost immediately, and revegetation will be monitored initially and periodically during the decade following planting. Elements of maintenance have been covered in sections on weed control, fertilization, and in the Operations and Maintenance Plan. About a decade after revegetation, monitoring will culminate with an evaluation that determines whether revegetation has been successful. If it is, natural processes will dictate further vegetational change along the SST OU.

In important respects, successful revegetation is expected to be self-maintaining. Although the role of plants in controlling erosion is widely recognized, disturbance is a key process in floodplains. Fluvial disruptions will reform the floodplain episodically. Stream dynamics can cause extreme or extensive changes to riverine sites due to soil erosion and deposition, blockages such as beaver dams and cutting of new channels, and changes in depth to groundwater resulting from sediment deposition (Leonard and others, 1992).

Revegetation prescriptions rely heavily on establishing species that have proven their suitability to the particular habitats involved. These species, identified while compiling a vascular plant species list for the SSTOU and studying plant:habitat relationships (Section 3.12.3.3), comprise the bulk of revegetation choices for wetlands and the transition zone within the SSTOU. Some are capable of reestablishing in raw habitats, while others are adapted to later stages of vegetational development and site modification. For example, one reason for planting willows is that they colonize raw habitats. "Whatever the scope or cause of the disturbance, willows are able to quickly colonize suitable sites to re-establish a former community or create a new one attuned to the new or altered substrate. Efficient colonization is aided by the production or abundant, lightweight, wind/water disseminated seed" (Brunsfeld and Johnson, 1985). The likelihood of

adapted, native species reestablishing following fluvial disruptions is far greater than for another class of species: those that could be established using agronomic practices, but which are unable to reproduce locally, and also unable to colonize fresh habitats when they become available.

Disturbance also is the force that creates and maintains wetlands. Consequently, maintaining wetlands requires a flexible approach and active management, in contrast to preservation methods appropriate to some forests and grasslands.

Historically, beavers were a key element of disturbance along Silver Bow Creek, and as recently as February 1998, a beaver frequented Reach A. In the willow establishment phase, however, beavers are undesirable. Willows with little root development can easily be pulled from the soil, and beavers have been known to pull enough willows in a few nights to effectively remove them from long stretches of the streambank.

The narrow band of woody plants along Blacktail Creek in Butte has received enough beaver damage in 1998-1999 to result in citizen complaints. This suggests that beaver colonization of the remediated floodplain will be rapid. Woven fencing for willow plantings in the floodplain is impractical, and beavers will have to be removed from revegetated areas until willow roots are well-established and sufficient carbohydrate resources have been stored for regrowth of cut stems. A minimum of three years of protection is prescribed, and five or six years would be better.

The intensity of beaver damage is expected to decline as the acreage of woody plants increases. This will take about a half-dozen years. Once established, willow regrowth is likely and roots are effective in streambank stabilization even when stems are cropped.

Beavers are not the only wildlife threat to revegetation. Legumes and young woody plants are magnets to ungulates, which are expected to find the new revegetation quickly and cause significant harm. Methods to control the damage are being considered, but the choice of tactics won't be decided until the problem is better defined.

J2. HYDROLOGICALLY DEFINED REVEGETATION ZONES

Along with physical and chemical soil properties, the hydrology of plant root zones will be critical in devising effective revegetation strategies. Delineating hydrologic zones is required by the Work Plan, which on p. 78 calls for the identification of plant zones for particular species based on their tolerance to inundation at high groundwater levels, desiccation, low and high flow duration, etc.

For areas requiring revegetation, hydrologic zones were defined, then mapped based on the predicted potentiometric surface relative to postremediation ground surface elevations specified in this plan (Abdo, 1998, pers. comm.). Here they will be called hydrologic zones, although they could just as well be termed "soil moisture regimes." Four hydrologic zones and a streambank category were identified for Subarea 1. Although the possibility exists that a site in the reconstructed floodplain will have a different hydrologic regime than anticipated, revegetation planning is better predicated on rather narrowly defined hydrologic regimes than on broad hydrologic classes to which no revegetation prescription can really be tailored. Following construction activities and a few weeks to establish equilibrium, depth to groundwater will be sampled, either confirming the revegetation prescription (Figure J1) map or calling for revision. For revegetation success, the appropriate strategy must be applied to the prevailing hydrologic regime, and species of dissimilar hydrologic requirement should not be planted together (Wilson, 1991).

J2.1 Streambanks

Streambanks usually are topographically distinct areas of relatively steep gradient and abrupt transition between the stream channel and adjacent slopes or terraces. For revegetation purposes, the streambank zone extends back 10 feet from the top of the bank. Details are contained in Section 3.8.4.

J2.2 Wetland Zone

Wetlands are fundamentally important to revegetation because if wetland hydrology is present in a restored landscape, those areas will become wetlands and must be revegetated with appropriate wetland species. Eventually, they will develop hydric soils. Saturation, periodic oxygen depletion, and accumulation of toxic plant metabolites will harm or kill many upland species if they are planted in areas with wetland hydrology.

The Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE) define wetlands as follows (Environmental Laboratory, 1987):

> Wetlands are areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

This definition includes hydrology, hydrophytic vegetation, and hydric soil components, but it is important to remember that hydrology is the driving force; soils and vegetation are or become manifestations of hydrology. It is hydrologic criteria that we have used to identify classes of wetlands for revegetation planning. Our working definition of wetland hydrology comes from the National Research Council (NRC, 1995), which lists on p. 93 four criteria for wetlands:

1. DEPTH of inundation or saturation in relation to the water table.
2. TIMING of inundation/saturation.
3. FREQUENCY of saturation or flooding.
4. DURATION of saturation or inundation in relation to growing season.

Thresholds are needed for each criterion, because thresholds define boundaries. Oversimplification is perhaps unavoidable, but to use hydrologic data in revegetation planning, thresholds must be defined:

1. DEPTH. With occasional exception, wetlands are inundated with less than two meters of water, above which an aquatic habitat is indicated (Env. Lab., 1987). At the lower threshold, seasonal saturation should be near the ground surface. Based on the generally coarse textural classes of soils and coversoils in Subarea 1, we assume that the saturation zone in Subarea 1 is the elevation of the potentiometric surface, i.e., the stream level adjacent to the stream, and from one to slightly more than two feet higher toward the floodplain edges (Abdo, 1997, pers. comm.). Capillary rise is not expected to be significant in Subarea 1 (Keck, 1997, pers. comm.).

The 1987 Manual calls for periodic inundation or saturation to the soil surface. However, examination of soil profiles calls for pits at least 16" deep, clearly indicating that wetlands may not be saturated to the ground surface often enough to manifest redoximorphic features there. Inundation or saturation within one foot of the ground surface is the critical zone for wetland delineation (NRC, 1995, p. 104); this corresponds to the control zone for very poorly drained soils in NRCS terminology. In defining hydric soils, the SCS (1991) includes all Aquic suborders and subgroups that are somewhat poorly drained and have a "frequently

occurring water table less than one-half foot from the surface for a significant period (usually more than two weeks) during the growing season" for sandy soils, or at a depth of one foot for less permeable soils.

2. TIMING. Wetland hydrology during the growing season is the critical factor for vegetation. That's when the free oxygen in the soil is depleted and anaerobic conditions prevail, and at the same time sulfur compounds and other plant toxins accumulate. We will assume that late May-mid-September, inclusive, is the effective growing season.

3. FREQUENCY. On page 34, Environmental Laboratory (1987) said, "It is essential to establish that a wetland area is periodically inundated or has saturated soils during the growing season." On the next page, the manual says that duration is more important than frequency, so frequency was omitted from the manual's Table 5, which defines wetland/nonwetland hydrologic zones.

In defining wetlands, many authors either downplay frequency or mention that wetlands must be inundated/saturated "periodically" (preceding paragraph) or "recurrently" (NRC, 1995). A frequency of one out of two years, or more frequently, seems to be the consensus (NRC, 1995, p. 107). However, this is more of judgment than a proven threshold, and frequency and duration interact in influencing many wetland characteristics.

4. DURATION. Environmental Laboratory (1987, Table 5, p. 36) lists 12.5% of the growing season as the minimal duration for wetlands, although some areas meeting this criterion could be nonwetlands. Based on a 120-day growing season, this criterion calls for 15 days of inundation or saturation. The definition of hydric soils also specifies a criterion of more than two weeks of saturation (SCS, 1991). Hammer (1997, p. 55) defined "wetland plants" as those capable "of growing in an environment that is periodically but continuously inundated for more than 10 days during the growing season." The Comprehensive Wetlands Conservation and Management Act of 1995, passed by the House but not the Senate, specifies that wetlands must have water present at the land surface for 21 days during the growing season. In contrast, the 1989 delineation manual (FICWD, 1989) specifies only seven days during the growing season. While we are aware that anaerobic conditions will develop more quickly in saturated soils at the end of June than at the beginning of May, we assume that two weeks or more of continuous saturation during the growing season is an acceptable threshold.

Summing up: in revegetation planning, wetlands are those areas inundated with less than two meters of water or saturated within a foot of the ground surface for two or more concurrent weeks in the plant growing season approximately every other year. In the SST OU, the hydrology of wetlands often will be determined by the potentiometric surface. We further distinguish inundated wetlands (those usually covered by water for more than two weeks during the growing season) from those usually saturated but less commonly and more briefly inundated. This distinction allows tailoring revegetation strategies to two classes of wetlands that differ significantly in redox potential and plant suitabilities.

Inundated Wetlands

Inundated wetlands have two important implications for revegetation planning. First, plants of inundated wetlands must have special adaptations for rooting in oxygen-depleted soils (= obligate wetlands species). Timing, depth, and frequency of inundation determine redox conditions that can shift the competitive balance between wetland dominants (Kludze and DeLaune, 1996), but fertility and litter accumulation also are important (Weiher and others, 1996).

Second, the low redox potential of soils provides for the mineralization of many elements, denitrification, etc., along with the accumulation of sediments, very slow plant decomposition, etc. Soils will be gleyed.

As long as these conditions prevail, inundated wetlands act as sinks or reservoirs in important respects. Under prolonged inundation, important plant nutrients are immobilized in the substrate and unavailable to plants. To a large extent, nutrients also are separated from surface water. Denitrification predominates except in the immediate vicinity of roots of certain macrophytes that leak oxygen to the surrounding substrate (radial oxygen loss). The ability of constructed wetlands to remove nitrogen and phosphorus compounds varied greatly, largely in response to temperature (Green and others, 1996). Phosphorus decreases and becomes less mobile due to humic hydroxy-Al and Fe surfaces (Sansen and Koedam, 1996) and iron can be reduced to a toxic form.

In wetlands with an inlet, primary productivity often is dependent upon continual nutrient inputs. Such inputs typically come from stream flow or overland flow. These sources of nutrients are expected to be very limited in Subarea 1. Plant growth in inundated wetlands without inlets will stagnate without periodic oxidation. Another limitation in inundated wetlands is that decomposition rates are only about 10% of aerobic decomposition rates (Hammer, 1997). From the plant's perspective, this also limits nutrient availability. A further limiting nutritional factor is that hydrogen ions dominate the exchange sites in wetland soils. Organic soils of the type expected to develop along the SST OU typically have lower hydraulic conductivity than mineral soils in Subarea 1, so even if groundwater contains plant nutrients and appreciable oxygen, it is unlikely to contribute much to plant nutrition once an organic soil develops.

Since diffusion rates of oxygen in water are very low, microbes using even small amounts of organic matter will consume most available oxygen in the soil. Thus organic matter quickly accumulates in saturated soils, but saturated soils with much organic matter will function similarly to soils with little organic matter, since available oxygen is all but absent. Many wetland plants thrive with little organic matter in the soil, although plant and litter are important as substrates for microbes that account for the purifying function of many wetlands. Once wetlands are vegetated, organic matter accumulates so quickly in saturated soils that organic amendment is not recommended (Groff, 1994).

The distinction between inundated and saturated wetlands is to a degree temporal, but revegetation prescriptions for the SST OU will be based on the prevailing hydrologic regime, realizing that species composition will shift with variations in inundation and sometimes saturation without inundation. Our approach follows the advice of Wilson (1991), who recommends matching the specific hydrologic requirements of individual species to revegetation sites, and not planting species of dissimilar hydrologic requirements together.

Saturated Wetlands

Wetlands are dynamic in many respects, including hydrology. Soils of saturated wetlands will alternate between aerobic and anaerobic conditions. Plants must be adapted to periodic saturation/inundation and at the same time must be competitive in aerated environments. Nitrification will alternate with denitrification, and elements will alternate between oxidized and reduced states. Plant communities must be in dynamic balance with changes in the redox potential. Saturated wetlands function differently than inundated wetlands with respect to flood flow alteration, water purification, sediment removal, wildlife use, etc. Productivity is expected to be higher in saturated wetlands than inundated ones.

J2.3 Wetland-Subirrigated Transition Zone

Clearly, the hydrology of wetlands varies temporally, both within and between years, and yet revegetation prescriptions should be tailored to rather narrowly defined hydrologic zones to increase the likelihood that species will be adapted to prevailing conditions. Thus, we distinguish a hydrologic zone along the gradient between wetlands and the subirrigated zone, discussed next. This transition zone comprises nonwetland

sites where the soil usually is saturated within one to two feet of the ground surface for at least two weeks during the growing season. This corresponds roughly to the control zone for poorly drained soils, using NRCS terminology. In this report, it may simply be called the transition zone. These areas will be tension zones, which terrestrial plants will colonize in dry periods because they typically can out-compete wetland plants. During wet periods, terrestrial species will perish and wetland-like plants will reestablish.

J2.4 Subirrigated Zone

Continuing to recognize the primacy of hydrology, the upper boundary of the subirrigated zone begins at the lower boundary of the transition zone. Thus, subirrigated areas do not meet wetland or transition zone criteria, but the soil usually is saturated within 3.5 feet of the ground surface for at least two weeks in the plant growing period. Since plant roots and microorganisms are uncommon at this depth in comparison to shallower depths, depletion of free oxygen will take longer and in any case oxygen will be available to shallow roots, so a longer duration of saturation might be justified as the threshold criteria. We have chosen to retain a two-week period for definition uniformity. The subirrigated zone corresponds to the "somewhat poorly drained" category of the NRCS.

So far, hydrologic zones have been defined by depth, duration, timing, and frequency of saturation for reasons previously discussed. However, as the depth to the seasonally saturated zone increases, it becomes less limiting to plants while remaining an important source of available water. For most herbs and particularly the grasses, the effective rooting depth is less than three feet and in some cases less than two feet. Therefore, a saturated zone three feet down neither challenges them, nor provides significant additional soil moisture to them in times of drought.

Trees, shrubs, and taprooted perennials have deeper roots that can tap moisture several feet down if they survive long enough to achieve that effective rooting depth. For roots to grow much below the capillary fringe, they must be adapted to anaerobic conditions at a seasonally varying depth. The capillary fringe in August may be the saturated zone in late spring.

In revegetation planning, the subirrigated zone will be seeded with the same or similar seed mixes as uplands because the critical establishment phase of those plants will be little affected by a seasonally saturated zone more than two feet below the ground surface. At the same time, subirrigated areas may be planted with deep-rooted species that may become phreatophytes. A number of revegetation strategies and species compositions can be utilized in the subirrigated zone.

J2.5 Upland Zone

This is a simple hydrologic category: the seasonally saturated zone more than 3.5 feet below the ground surface, beyond the effective rooting depth of most plant species and too deep to establish water-loving plants except by extraordinary measures. In unconsolidated sandy sediments, drought poses a risk to young plants during the establishment phase, and in extreme cases to otherwise suitable mature plants.

J3. SOIL AND COVERSOIL CLASSES

Soil texture and geologic/geomorphic origin are the main determinants of soil and coversoil classes. Coversoils originate as borrow material. Texture is know generally from sampling and can be confirmed during excavation, providing some quality assurance. Textures are known for in situ soils from a limited number of samples indicated in Figure J2. The spatial relations of substrate textures are unknown, and delineations separating classes were made to assist revegetation mapping but are not definitive. Soil textures as well as hydrology will be confirmed following floodplain reconstruction and prior to revegetation.

Three classes of soils/coversoils have been identified Subarea 1. Within Reach A, no hydrologic zone received prescriptions for more than two soil classes, and some for only one class. However, more classes might be recognized for a longer or more diverse stream segment. Except for special seedings in tree and shrub planting areas, seedings areas will be of a size where farm implements can be used.

J3.1 Class 1 Soils

These are the coarsest soils suitable for revegetation. These areas will require more maintenance in the form of fertilization and weed control than other areas.

The main category of Class 1 soils is situ soils where texture is loamy sand or coarser. Most Class 1 soils occur in uplands north of the floodplain, but there is some in situ Class 1 soil within the floodplain in wetlands and the transition zone, where the coarse texture will pose few revegetation limitations. Generally, particle size classes are one-half to two-thirds sand, one-third silt, and about five to six percent clay.

Similar coversoil material has been used on the Butte Hill revegetation with limited success. Even the best portions of this material are marginally adequate for uplands/subirrigated sites where annual precipitation averages 12 inches. These coversoils will be extremely droughty and infertile, and these limitations are most evident on warm aspects. Water infiltration and percolation will be rapid, so overland flow is unlikely and most of the precipitation that falls on these coversoils will enter them, but at the same time heavy rains or rapid snowmelt will quickly penetrate beyond the zone of young plant roots. This poses a problem in the establishmen phase, i.e., the first two years. Under warm, sunny, breezy conditions, the upper inch may go from field capacity to the permanent wilting point in one day. Root penetration will be great, at least down to residual soils or substrates. Capillary rise will hardly exist.

In addition to being droughty, Class 1 soils have low nutrient-holding capability. Granitic parent material tends not to weather to secondary minerals, so inorganic colloids are few. At the same time, organic matter, including colloids, oxidize quickly due to the high rate of gas exchange and oxidation potential. Thus, humus accumulation will be slow once soil microbes become established, so development of soil structure will be retarded. Establishing weed-resistant plant communities will be difficult.

In uplands, revegetating Class 1 soils without compost and with a weedy seed bank will be challenging, and moisture conditions in the establishing year probably will have a lot to do with ultimate success. Compost is being tested on two acres in Reach A.

J3.2 Class 2 Soils

Class 2 soils consist of finer-textured soils from Borrow Area 10 (sandy loams with about 10% clay) and in situ soils of sandy loam and silty loam texture. Although the average textural class remains that of a sandy loam, Borrow Area 10 material has almost twice the average clay content of Class 1 soils. Borrow Area 10 comprises a complicated mix of suitable and unsuitable materials. Texture generally may correspond to origin (e.g., tufaceous vs. granitic). Class 2 soils are better-suited texturally for upland and subirrigated coversoils than granitic alluvium, and they are fully satisfactory for wetlands and the transition zone as well.

J3.3 Class 3 Soils

Some in situ soils comprise finer textural classes than the first two soil classes. Class 3 soils have an indicated texture of silty clay loam and clay loam, although there apparently was a bias toward finer texture in estimating textures. These soils too are suitable for any hydrologic zone.

J3.4 Integrating Hydrologic Zones and Coversoil Classes

Revegetation habitat types are combinations of coversoil classes and hydrologic zones. The Work Plan (p.51) calls for "a map set indicating the location of revegetated plant communities." How the integration of hydrologic zones and soil classes played out in Reach A was described earlier in this appendix (design components) and is portrayed in Figure J1.

J4. PLANT NUTRITION AND NUTRIENT CYCLING

Plant nutrition strategies must include nutrients in the soil and their form, the ability of plants or plants in conjunction with fungal associates to access them, and the need for a continuing supply of nutrients. Nutrient cycling is largely dependent on the relative growth rates of the active fraction of the bacterial biomass (Ladd, 1985), but other soil organisms such as fungi and protozoa also must be considered critical (Ingham, 1998, pers. comm.). Loss or absence of nitrogen-fixers or nitrifying bacteria severely limits site productivity (Ladd, 1985).

The borrow materials that will serve as coversoils and in situ substrates exposed when tailings/impacted soils are removed lack essential plant nutrients, organic matter, and the spectrum and quantity of soil organisms typically found in living soil. As a growth medium, this presents several limitations with respect to establishing some types of nutrient cycling. Some limitations are physical: there will be no soil structure and cation exchange capacity will be dictated solely by soil clay particles and inorganic colloids. For some coversoils and Class 1 soils, these are limited. Other limitations are chemical and biological: coversoils will lack carbon and nitrogen reservoirs, and supplying nitrogen with mineral fertilizer will satisfy plant requirements for the short-term only. Providing most other nutrients in mineral form is likely to be a long-term solution if nutrient cycling is tight.

The goal of plant nutrition strategies is to assure that there are sufficient essential plant nutrients in the system in plant-available form along with reservoirs of temporarily unavailable nutrients. Nutrients may be organic or inorganic, oxidized or reduced, plant-available or not. Nutrients may be in the soil solution, on exchange sites, in living or dead plant material, and in soil organisms. Natural additions to the pool of plant nutrients are small. In a healthy system, losses (e.g., from leaching, volatilization, and herbivory) also are small. Once pools of important plant nutrients are present, they are recycled through the plant-animal and soil-atmosphere systems with rather small losses that are compensated by inputs. Nutrient cycling refers to this constant cycling of macronutrients and micronutrients so that each element is constantly returned to the soil and made available for plant use. Nitrogen cycling is more complicated than most cycles; providing adequate nitrogen in coversoils and establishing nitrogen cycling is one of the challenges of revegetating coversoils that originate as deep borrow material.

J4.1 Nitrogen

Nitrogen Cycling

Natural soils in floodplains and uplands similar to the Silver Bow Creek area have achieved a degree of nutrient cycling adequate to support plant communities with natural inputs, which are slight without cyanobacteria. This is not to say that plant-available nitrogen levels are optimal for plant growth. Although water is usually considered to be the primary limiting factor in semiarid areas, and indeed there is a linear relationship between plant productivity and seasonal precipitation for equilibrium grassland plant communities in Montana (Prodgers, 1988), the climate near Sidney, MT, can support two to three times more plant growth than is naturally produced when nitrogen is not limiting (Wight, 1974). Another study from the Havre (MT) area found that nitrogen fertilization increased total grass production for six years (length of

study) by a factor of about four compared to unfertilized controls (Houlton, 1974). Wight (1974) concluded there exists a nitrogen sink in native rangelands, and that the sink must be satisfied to maintain a high level of productivity.

Vascular plants cannot use atmospheric nitrogen gas directly, although some photosynthesizing cyanobacteria can. While nitrogen may be present in soil minerals (very little in igneous rocks), it is unlikely to be released quickly enough even from marine shales via weathering processes to provide much of the nitrogen that plants require (Reeder, 1990). For plant uptake, nitrogen must be in a mineralized form: nitrate ions (by far most important) or ammonium ions. There may be some uptake of amino acids or other organic nitrogen, but this usually is minimal where nitrification is established.

Nitrogen inputs are typically meager, on the order of two to nine kg/ha/yr without significant nitrogen fixation. These small amounts of nitrogen can be fixed by lightning and meteorites and brought to earth by rainwater, or fixed by nonsymbiotic bacteria such as *Azotobacter* in the root zone. Losses are even lower from natural and seminatural plant communities (Reeder, 1990), depending on the level of cropping. Thus, over long periods of time, there is a slight natural nitrogen enrichment of vegetated soils. Without tight nutrient cycling and the translocation of nitrogen from aging plant herbage to perennial tissues (crowns, roots), then back to perennating tissues the next growing season, available nitrogen would be inadequate for current productivity levels in western grasslands and shrublands.

More than 99% of the nitrogen in productive western grassland soils resides in organic matter (Reeder and Sabey, 1987). Most of these organic compounds resist decomposition, and less than 1% is mineralized annually. In some grasslands of the western United States, organic matter can contain around 5,000 kg N/ha. In comparison, plant biomass plus litter might hold about 220 kg/ha, and soil microbes another 75 kg/ha (or more, Ingham 1998, pers. comm.). The nitrogen content of soils usually is approximately one twentieth of the organic matter (Alexander, 1991, p. 11). Organic forms include proteins, amino acids, nucleotides, etc. in plants and soil organisms. The nitrogenous compounds in soils resist microbial attack and are persistent, so only a small portion is mineralized each growing season. During the process of ammonification, bacteria and their predators (protozoa and bacteria-feeding nematodes) and fungi and their predators (fungi-feeding nematodes and microarthropods) break down organic nitrogen, using some for their own metabolic needs, and releasing unused nitrogen as ammonia (usually). In the soil, this forms ammonium ions. There is a dynamic balance between plants and soil heterotrophs: if soil microbes tie up too much nitrogen, plants suffer. If little nitrogen is available for soil microbes, their populations will diminish as will their grazers and predators.

Chemoautotrophic soil bacteria such as *Nitrococcus* and *Nitrosomonas* oxidize ammonia or ammonium ions to nitrite. Another genus of bacteria, *Nitrobacter*, converts nitrite to nitrate. Plants are very efficient in taking up nitrate. This phase of the nitrogen cycle (nitrification) makes organic nitrogen plant available. Because of nitrification, nitrate is the form in which almost all nitrogen is absorbed by plants in temperate grasslands. Of course, soil bacteria and fungi incorporate nitrogen for their own metabolic needs. Other soil organisms graze on the bacteria (e.g., protozoa) and eat the fungi (nematodes, some protozoa), promoting the cycling of nitrogen in the decomposers. These too have their predators.

Summing up, aerated natural soils have a nitrogen pool that may have taken centuries to accumulate, and a complicated assemblage of plants and soil organisms that reduce and oxidize nitrogen as it cycles through the various components. Following initial fertilization, three options are available to provide nutrients and promote or establish nutrient cycling. These options differ significantly in their likelihood of success, cost, and role in weed control.

Compost

Coversoils originating as deep borrow materials (below the zone of primary biologic activity) have neither a nitrogen pool nor the diversity and quantity of organisms necessary to establish nitrogen cycling. This has been determined from sampling and analysis. A similar situation also describes in situ substrates below tailings/impacted soils except possibly where the buried A or B horizon becomes the new ground surface. The most costly and least risky option is to incorporate compost into the upper six to 12 inches of coversoils. This directly and immediately tackles the problem by providing an organic nitrogen pool along with carbon resources that provide an energy source for soil organisms. Properly prepared compost also contains soil microbes necessary for nitrogen cycling and in any case colonization is likely in the narrow floodplain of Subarea 1 due to the proximity to donor sites (Ingham, 1998, pers. comm.).

The effectiveness of rather heavy organic amendment on plant performance in Butte was demonstrated at the Texas Avenue test plots. Fifteen years after seeding, plant canopy cover on a stockyard manure treatment (approximately 300 cy/A) was twice that of treatments without organic amendment, and a few grass species prospered on the stockyard manure treatment but none persisted on treatments lacking organic amendment (Prodgers, 1998a). The addition of organic amendments also may increase the mycorrhizae development rate (Johnson and McGraw, 1988, as cited in Miller and Jastrow, 1992). The risk of introducing persistent weeds, plant pathogens, or mycorrhizal fungi that produce little growth response in host plants from unprocessed stockyard manure makes it a poor alternative to compost.

Organic matter is an expensive option. Amending the upper six inches of coversoil to achieve an organic matter content of approximately 1% can cost more than $2,000/acre. Elaine Ingham (1998, pers. comm.) recommended more than 0.5% but added that 1% organic matter may be better for soil microbe and plant performance than 2%, so perhaps a target of 0.75% organic matter in the upper six inches of coversoils could be considered minimal. The organic matter of compost further rapidly decomposes for a year or two following application (Jacobsen, 1998, pers. comm.), so an application rate of around 1.25-1.5% is desired.

At this time, amending coversoils with compost is planned only for special applications (e.g., the repository) and test plots identified within the remediated area. Compost will be applied to the repository because revegetation success is critically important there. As a test of compost compared to incremental mineral fertilization alone, two acres of Class 1 soil material with weedy seedbank in the upland zone will be amended with compost in Reach A.

The nutrient content of compost also must be considered in prescribing it. Legumes/*Rhizobium* are important components of most seed mixes. They are not as important to nitrogen cycling where organic amendments are part of the prescription as elsewhere, but in repositories these symbionts play a role in rapid uptake of soil moisture. Elevated nitrate levels inhibit establishment of bacteria necessary for nitrogen fixation and also nitrification. In Butte, coversoil amendment with stockyard manure has been shown to reduce the abundance of alfalfa and red clover (Prodgers, 1998a), and Gomm (1969) found that fertilizing grass-legume communities with nitrogen decreases the relative amount of legumes. In revegetating Subarea 1, the goal is to have a nitrogen pool but not excess nitrate. Nitrogen fixation is likely to establish with nitrogen in the soil below approximately 12 ppm (Jacobsen, 1998, pers. comm.). Therefore, compost used in Reach A should have an available N concentration between 300-600 ppm N (nitrate plus ammonium). For VAM to establish, compost should contain between 150-450 ppm P (Olsen test).

Some compost products have some much available N that they cannot be applied at rates that provide desired levels of organic matter without inhibiting nitrogen fixation. Moreover, high nutrient levels select for vascular plant species that can effectively use lots of nutrients. The response of native species is complex, with some profiting from large doses, others responding to moderate fertility then declining, and some

showing no benefit from virtually any level of fertilization. The species selected for in fertile sites usually are not those best suited to the long term after fertility levels decline, but by then those species are gone – lost the competitive battle.

Finally, compost products can vary greatly in their contribution to a healthy soil microflora and microfauna (Prodgers, 1998b). Reach A will use compost containing >100 ug total bacteria/g dry compost and an equal biomass of fungi, >30,000 protozoa per gram dry weight compost, and no root-feeding nematodes.

Nitrogen Fixation

A second option is to initiate nitrogen fixation. Nitrogen fixation is an anaerobic process whereby gaseous nitrogen is reduced to ammonia for plant uptake. In the context of establishing healthy revegetation, this is done mainly by the *Rhizobium* genus of symbiotic bacteria in conjunction with legumes (pea family), although some members of the aster family (e.g., *Artemisia ludoviciana*) also can form symbiotic nitrogen-fixing relationships. Different species of *Rhizobium* infest the root hairs of young legumes, such as alfalfa, black medic, American vetch, clover, golden-pea, and some other species included in Subarea 1 seed mixes. Root "nodules" (look like tumors) are the sites of infected and noninfected cells. It is here that nitrogen gas is made available for plant metabolism. Most of this nitrogen doesn't become available to other plants until the host plant decomposes, but some nitrogen may enter the soil directly from the plant root hairs. Many free-living bacteria, including some cyanobacteria, also provide nitrogen fixation. Since they are photosynthetic, they are found on the soil surface and appear as a soil crust. Their nitrogen is little shared with vascular plants, and the soil crusts they form inhibit higher plant establishment from seed and contribute to overland flow. Only when the crusts are broken and moisture can infiltrate does the nitrogen become available to vascular plants.

The effectiveness of alfalfa in revegetating mine spoil was demonstrated near Hayden, Colorado. After five years of alfalfa growth, spoil and soil had similar quantities of total nitrogen (1100 mg/kg vs. 1200 mg/kg). In contrast, fresh spoil had 700 mg/kg, largely originating with the marine parent material. Mineralizable nitrogen, a better index of soil fertility, was 70 mg/kg in soil compared to 50 mg/kg in alfalfa spoil and five mg/kg in fresh spoil. Plant performance was about equal in soil and alfalfa spoil, and both were almost twice that of fresh spoil (Reeder and Berg, 1977a; 1977b). The authors concluded that five years of alfalfa growth were sufficient to reestablish the rapid-cycling portions of the nitrogen cycle (Reeder, 1990). Irrigated pastures with >40% relative abundance of legumes were similar in productivity to grasses which had been fertilized with 300 pounds of nitrogen per acre (Gomm, 1969). At test plots in Butte more than 15 years after planting, the concentration of nitrate in coversoil where alfalfa was grown was 2.9 mg/kg compared to a concentration below the detection limit (<0.1 mg/kg) in nearby plantings (weedy failures) on the same substrate (Prodgers, 1998a). At that time, alfalfa plantings were the only successes among 20 plantings on sites that did not receive organic amendment.

Nitrogen fixation is an alternative to organic amendment because it can foster rapid nitrogen cycling while organic matter accumulates in and on the soil. Our hope is that by the time legumes become scarce (legumes typically are uncommon in our native grasslands), nitrogen cycling will be established at an adequate level without continual additions from nitrogen fixation.

In revegetation, nitrogen fixation is an important element of non-wetland revegetation. Inoculated legume seeds will be planted in all non-wetland sites lacking a weedy seed bank.

The risk in relying on nitrogen fixation, assuming the symbiotic association establishes, is that the legumes will in time diminish to the point where little nitrogen is being added to the soil-plant system. Our view is that the cost savings of nitrogen fixation when compared to compost warrants taking some risks. Five years of

effective nitrogen fixation will go a long way toward satisfying the nitrogen sink, but a few decades would be even better..

Mineral Fertilization

In the early years, revegetated sites will tend to accumulate biomass and nutrients on the road to stabilization. Simply stated, there is not enough nitrogen to go around. Vascular plants and soil microorganisms need litter at the same time nitrogenous substrates are beginning to accumulate. This is what is meant by "a nitrogen sink". Vascular plant growth and decomposition both will suffer from a dearth of nitrogen. This is what makes nitrogen fixation so desirable in revegetation, but nitrogen-fixing plants/bacteria may not establish at effective levels at all sites where they are planted, and no forbs are being planted in weedy-seed-bank uplands.

Where legumes do not establish effectively, the key is to provide rather light increments of nitrogen fertilizer when nitrogen becomes limiting, which in our area tends to be May-July. Additions of nitrogen fertilizer equal to the amount channeled to soil/surface organic matter will be needed to sustain plant growth until the rapid-cycling portion of the nitrogen cycle establishes (Reeder, 1990). At the time of seedbed preparation and mulching, about 100 pounds/acre of urea should be incorporated into the soil with other fertilizer elements. Urea is converted to plant-available form by soil microbes that manufacture the enzyme urease, and encouraging these microbes is desirable. If mulch is to provide a cover crop, some nitrogen must be available for the annual grasses (e.g., wheat or barley).

Depending on the amount of legumes (or other nitrogen fixers) in the revegetation and their effectiveness in providing plant-available nitrogen, additional nitrogen applications may be required either for plant nutrition or to adjust the carbon: nitrogen ratio. Where legumes don't establish well, this will have to be repeated for five years or so. Nitrogen fertilization is anathema to nitrogen fertilization, so it won't be practiced where legumes establish well. The presence of ammonia and nitrates suppresses nitrogen fixation because the symbiosis is self-regulating, providing just the right amount for host plant needs.

The long-term goal is to establish nitrogen cycling, a process in which nitrogen is alternately reduced and oxidized, but essentially conserved within the plant-soil complex. Where legumes do not effectively establish, two light applications of nitrogen (approximately 35 pounds urea/acre) between late May and the end of July are prescribed. The trick in relying on inorganic fertilizer is to provide the plant with its nutritional needs at the appropriate time without shifting plant community composition in a way deleterious once fertilization stops, without suppressing nitrogen fixation and promoting root pathogens, and without contaminating groundwater. (The nitrate ion is negatively charged and thus is not held by negatively charged colloids).

Soil microbiologists view moderate to high additions of mineral nitrogen to soils as harmful to soil health. Vascular plants may be less effective in utilizing nitrogen fertilizer in spoil (coversoil) than soil due to lower CEC and soil organism populations (Reeder, 1990). In research at rather high altitude in Austria, microbial biomass was lower and organic matter was accumulating more slowly on mineral fertilized plots than organically fertilized sites (Insam, incomplete citation). However, the alternative of not fertilizing is unlikely to establish an adequate nitrogen pool and nitrogen cycling, which has been implicated in revegetation failures in Butte uplands (Prodgers, 1998a). Mineral nitrogen fertilization for five years is unlikely to provide coversoils initially devoid of nitrogen with enough of a nitrogen pool to sustain enough plant cover to prevent erosion and limit weed invasion. A good compost or nitrogen fixation are preferred. The economic reality is that incremental fertilization will have to be used some places.

It is often asserted that mineral fertilization benefits weeds most. The amount of forbs, including weeds, in native prairies, foothills grasslands, etc. generally is suppressed by the grasses, which are better-adapted to decently developed soils of rather low fertility in the sense that very small amounts of many essential nutrients are available at a given moment. Upon applying nitrogen-phosphorus fertilizer to native grass sites in western Canada, Kilcher and others (1965) observed that weeds grew and proliferated most rapidly. Their relative as well as absolute abundance remained high for one to two years. Thereafter, weeds dropped back to a subordinate role, and comprised an even smaller percentage of the annual production than did weeds in unfertilized plots.

Weeds, especially those classified as "noxious," are by no means restricted to fertile sites. Spotted knapweed, by far the most prevalent weed in Butte-area uplands and subirrigated sites but not the hardest to control, was the most abundant species at the Texas Avenue test plots on both manured and untreated treatments 15 years after planting. These treatment areas differed greatly in fertility. Both total plant cover and knapweed cover were twice as high on the manured substrate (Prodgers, 1998a). Knapweed obviously has a wide range of adaptation to soil fertility. Based on observations on the Butte Hill, sites so infertile that knapweed abundance is strongly limited are too infertile or in some way plant-limiting for desirable perennials to prosper, and these sites are predominantly barren. Two species of toadflax also are important weeds of nonfertile sites at Butte. Leafy spurge has dominated some poor-quality sites in the Deer Lodge Valley and in the Silver Bow Creek floodplain. Cheatgrass, a rather minor weed at Butte except on manured or fertilized sites, may potentially become important on nitrogen-rich sites. Control is very difficult if not impossible.

Among desirable perennial species, soil fertility is a driving force in determining species composition. Most important range grasses in Montana respond favorably to nitrogen fertilization up to 50-100 pounds/ acre. Beyond that, some continue to increase production up to very high nitrogen fertilizer rates (300-600 pounds/acre). Others do not respond or respond negatively to high rates of fertilization. (The response of species is complicated, sometimes contradictory, and has been reported mainly for species not being used in streamside revegetation. See 1974 Range Fertilization Symposium, Havre, MT.) Obviously, if some species respond positively and some little or negatively to a given factor, the influence of that factor on plant community composition will be profound. This is unavoidable, but by limiting nitrogen applications to approximately 16 lbs/A at a time, the effects will be minimal although perhaps still consequential.

Fertilization leads not only to increased plant vigor and growth, but also to more rapid soil moisture depletion -- a desirable feature for repository caps. Citing four authors, Ryerson and Taylor (1974) concluded that higher efficiency of soil moisture use and moisture withdrawal to greater depth usually prevents nitrogen leaching through the soil profile in the 10-14" precipitation zone. Another researcher in Montana (Wight, 1974) found that unless recharged by autumn rains, fertilized plots entered the winter months with considerably lower soil moisture content than nonfertilized plots. It seems that nitrogen fertilization can increase the amount of precipitation that is used for plant growth. Yields indicated almost complete carry-over of unused nitrogen fertilizer from drought years.

Summing up: A program of inorganic fertilization will be used where compost was not applied and legumes do not effectively establish. It is expected to be the least effective program for establishing nutrient cycling, but it is expected to be satisfactory in the short- to mid-term. The alternative of not fertilizing following seedbed preparation or planting has virtually no chance of establishing nitrogen cycling.

J4.2 Potassium, Phosphorus, and Cobalt

Standard mineral fertilizer contains phosphorus and potassium as well as nitrogen. Phosphorus and potassium are essential inorganic macronutrients. Cobalt is a trace element required by nitrogen-fixing organisms (bacteria) and probably most microorganisms (cobalt is necessary for B-vitamins), but the

concentration needed is a small fraction of 1 ppm. A light application of one pound/acre cobalt with other fertilizers is prudent. Where already present in revegetation substrates or where added during seedbed preparation, these three elements are expected to remain in the plant-soil system, providing adequate plant nutrition. All three could be incorporated with a chisel plow to a half-foot depth or more (e.g., 12" depth, 24" tooth spacing).

Potassium often reaches higher concentrations in plants than any elements other than carbon and oxygen. When more of this element is present in the soil, more is taken up by the plant. Legumes in particular accumulate potassium. This can result in most potassium being tied up in plant tissue and litter and not enough available in the soil solution. Potassium will be included in fertilizers because it probably will enhance plant performance even when "enough" is already present. Some coversoils on the Butte Hill were found to be deficient in this element (Jensen, 1997, pers. comm.), but our sampling of BAs 1 and 10 indicate adequate potassium levels, and some in situ soils also are adequate. Less is retained in sandy loams than clay loams because the extent of fixation as insoluble compounds is proportional to the amount of colloidal matter. Therefore, less should be applied to soils with little clay than heavier soils.

Phosphorus is needed by all plants, but especially nitrogen-fixing plants. Plants receiving plenty of phosphorus have better drought tolerance and enhanced root tip elongation compared to plants deficient in phosphorus uptake (St. John, 1996). Native range plants often don't respond to the addition of phosphate, but this may be due to their mycorrhizal associations, which secure adequate phosphorus from otherwise deficient soils. This macronutrient is used by plants in anion forms, but it readily forms relatively insoluble compounds with metals.

Where phosphorus is inadequate for good plant growth, the safest strategy is to incorporate phosphate to depth with a chisel plow during seedbed preparation, even if this occurs months before permanent planting. Our target level for soils where VAM will be applied is a conservative 10 ppm (Olsen method). Only BA 10 materials appear to need additional phosphorus, around 25 lbs./A. Heavy rates of fertilization prevent successful mycorrhizae formation, and yet associations with legumes including alfalfa are common, suggesting that it is phosphorus rather than nitrogen fertilization that limits VAM establishment. This argues for minimal phosphorus fertilization, but where mycorrhizae fail to establish, phosphorus may be inadequate for revegetation, particularly legumes.

The addition of organic amendments may increase the rate of mycorrhizae development (Johnson and McGraw, 1988, as cited in Miller and Jastrow, 1992). Composts contain phosphorus, which complicates the picture. Our strategy of inoculating with VAM requires that phosphorus be sparingly available. The fungal associate is likely to establish where the phosphorus concentration is below approximately 10 ppm (Jacobsen, 1998, pers. comm.) or perhaps a little higher (St. John, 1998, pers. comm.). High phosphorus concentrations in compost can limit the amount that can be applied to coversoils if mycorrhizal associations are to form.

Cobalt is a trace element, not essential for many taxa. Where legumes are planted to assist in nitrogen fixation, a light application of cobalt is recommended if absent from the soil. Nitrogen fixation is the primary alternative to compost, so assuring adequate plant nutrition to these vascular plants/bacteria will be directly related to revegetation success.

J4.3 Mycorrhizae[1] and Plant Nutrition

The preponderance of perennial plant taxa is thought to form mycorrhizal associations – a symbiosis of plant and fungi that aid in the uptake of nutrients and water in the soil by accessing a larger volume of soil through mycelia than plant roots alone. St. John and others (1997) believe that mycorrhizal fungi are the most important components of soil microbiology. Plants may divert up to 80% of the net carbon fixed in photosynthesis to belowground processes, including root growth and to feed mycorrhizal fungi and other soil organisms. The plants are repaid by effects on nutrient cycling, pathogens, soil aeration, and nutrient- and water-holding characteristics (Perry and Amaranthus, 1991). Where nonspecific endomycorrhizal fungi combine with plant community dominants, hyphae may interconnect to form mycorrhizal links between plants (Newman, 1988), including species of differing growth-forms (St. John and others, 1997). Evaluating plant community dynamics in the usual way (i.e., focusing on aboveground portions of plants) may lead to a faulty conception of these plant communities.

Grassland and shrubland vascular plant species tend to be endomycorrhizal, whereas plants of early seral stages (including many weeds) are nonmycorrhizal or facultatively mycorrhizal. In the Powder River area of Wyoming, 95% of the dominant species had mycorrhizal associations, with up to 96% of the roots length colonized (Christensen and Williams, 1977, as cited in Steinbacher, 1997). A comparison of plant roots in a midelevation sagebrush/grass community and an old roadbed through this community revealed that more than 99% of plants in the natural community were mycorrhizal (vesicular-arbuscular), whereas less than one percent of plants in the roadbed were mycorrhizal (Reeves and others, 1977). Lack of mycorrhizal fungi in revegetation can lead to the continued occupation of the site by nonmycotrophic species (Miller, 1987). Annuals and biennials rarely form mycorrhizal associations because they weather stress periods as seeds and usually have more root hairs than perennials. Endomycorrhizal fungi often are called vesicular-arbuscular mycorrhizae (VAM) or just arbuscular mycorrhizae.

Plants in mycorrhizal association have a much larger root-hyphae volume for nutrient/water absorption than plants with few or no mycorrhizae. VAM are especially well-known for making adequate phosphorus available to plants in soils that would otherwise be deficient in this element. A phosphorus depletion zone forms around roots. When present, many mycorrhizae play important roles in phosphate uptake due to the increased spatial distribution of hyphae relative to roots and possibly the ability to extract phosphorus from more dilute soil solutions. Lateral branches of hyphae proliferate near nutrient-rich microsites, effectively shortening the average pathway along which phosphorus must diffuse (St. John and others, 1983). Plants receiving plenty of phosphorus have better drought tolerance and enhanced root tip elongation compared to plants deficient in phosphorus uptake (St. John, 1996). Native range plants often don't respond to the addition of phosphate (Wight, 1974), but this may be due to their mycorrhizal associations, which secure adequate phosphorus without supplements.

At one scale, mycorrhizae are associated with the day-to-day functioning of plants through their roles in nutrient and water uptake, thereby influencing growth, reproduction, vigor, etc. On a different scale, the extraradical hyphae of VAM fungi can be important agents of soil aggregation and also favor the growth of beneficial bacteria in the root zone (St. John, 1996). Mycorrhizae also function to protect delicate absorbing root tissue from soil pathogens and soil phytotoxins, at least for ectomycorrhiza in conjunction with Douglas fir seedlings (Zak, 1971) and VAM in conjunction with other taxa (Linderman,1994).

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[1] Mycorrhizae (pl.), literally "fugus-root," a compound structure. Each tubular filament of the fungal partner is a hypha (pl. hyphae); the mass of hyphae collectively form the body of a fungus, called mycelium.

Resistant soil aggregates help prevent wind and water erosion. Whereas bacterial slimes are important agents of microaggregation, fungi are responsible for a lot of macroaggregation and contribute to soil structure. The development of soil aggregates and encapsulation of organic matter within them is important in creating a nutrient reserve. Formation of soil aggregates is complicated and not fully understood, but in rhizosphere soils, extraradical hyphae physically entangle primary soil particles, followed by physical entanglement of organic matter and mineral particles by roots and hyphae to form microaggregates. At the same time, persistent organic binding agents (e.g., polysaccharides) cement and stabilize microaggregates (<0.25 mm), clays, and organic matter into macroaggregates, again with the help of extraradical hyphae (Miller and Jastrow, 1992). These agents of organic cementation arise from residues of mycorrhizal hyphae, root cells, and soil microflora. Miller and Jastrow (1992) concluded that, "Both revegetation and aggregation contribute to the accretion of organic matter," and that the encapsulation of organic matter within soil aggregates could lead to more conservative nutrient cycling.

These fungal associates of plants are effectively absent from borrow materials below the topsoil, which in some cases contains pathogens (Ingham, 1998, pers. comm.). Lack of mycorrhizal fungi and other rhizosphere organisms probably will have the greatest negative impact on those droughty or otherwise stressful sites where seedling survival depends on rapid exploitation of soil (Perry and others, 1987). Perry and others (1989) thought that the most promising candidates for restoring mycorrhizal fungi are soils where water or nutrients are lacking, and climates with short growing seasons.

Lack of mycorrhizae makes borrow materials better-suited as growth media for weeds than perennials. Not only are mycorrhizae unlikely to be of practical significance in coversoils, without inoculation they are unlikely to colonize revegetated semiarid sites in less than a half-dozen years and possibly longer (Miller and Jastrow, 1992, Table 13.4). VAM invade new habitats slowly because wind dissemination plays a small role, and typical animal disseminators are few here (e.g., earthworms, burrowing critters). A no host/no fungi feedback loop can limit nutritional improvements.

Along the SST OU, these conditions (from Miller and Jastrow, 1992) suggest that VAM would be desirable: 1) density of inoculum low, 2) site is either extremely arid or hydric during some portion of the growing season, 3) cold temperatures when moisture is adequate for plant growth, 4) low mineral nutrient content of soil, and 5) potential for toxicity of soil to plant growth. (The last condition may apply to some in situ soils, not borrow materials.) Unless the proper fungi are introduced into coversoils, nonmycotrophic species are likely to remain abundant, whereas mycotrophic species are preferred.

Vesicular-arbuscular mycorrhizae are widespread and relatively unselective with regard to host plants; there are fewer than 200 species of fungi (zygomycetes) involved in mycorrhizal association worldwide. Nonselectivity makes them desirable in coversoils. In the past, the use of VAM in revegetation seedings has been limited because they cannot establish without hosts, yet they need to be incorporated into the soil. Surficial applications of spores are ineffective. Inocula must be placed in the root zone, preferably in a single layer. The actual amount of spores needed is almost infinitesimal: less than 5 grams/Ha (Daniels and Menge, 1981). Dispersing the spores is another matter, and pure spores deteriorate more quickly than spores protected by plant roots or attached to certain protective carrier materials. In practice, application rates of inoculum have run into metric tons/Ha of material including spores. Using soil or manure as inocula risks introducing plant pathogens or mycorrhizal fungi that produce little growth response in host plants. They should be added just before seeding if practical. At present, inoculating coversoils appears to be feasible because the fungal component of VAM is markedly unselective with regard to host plants. Details of introducing mycorrhizal fungi for revegetation have been presented by Ted St. John (1996, 1998). The cost of one product used on the Butte Hill is $280-400/100 lbs. FOB, which is a recommended application rate per acre.

The sheathing or ectomycorrhizae associate with fewer partners, but these include willows and conifer. These fungi can be cultured and vegetative mycelium can be mass-produced, but fungi-host relations tend to be specific. Their potential use in revegetating the SST OU is limited to planting inoculated shrubs or dropping natural inocula into the soil when transplanting. Inoculated shrub and tree seedlings will be used when available from the selected nursery.

Associations of the VAM type rarely form in saturated soils, although it does happen (Turner and Friese, 1998; Rosales and others, 1997). Overall, mycorrhizal inoculation is inappropriate for wetlands. VAM probably will benefit plant performance in the transition zone because the upper foot of soil usually is not saturated during the growing season, but the *Carices* typically are not mycorrhizal. Probably VAM will be beneficial for areas within the transition zone that are seeded and less so for plug-planted areas.

Healthy alfalfa almost always is mycorrhizal (Ingham, 1998, pers. comm.). Thus we see no conflict of mycorrhizal and *Rhizobium* inoculations.

J5. CITATIONS

Abdo, G. 1998. Personal communication regarding: defining and mapping hydrologic zones for revegetation planning. Ms. Abdo is hydrogeologist with the Montana Bureau of Mines and Geology and has been involved with this project for several years. February.

Abdo, G. 1997. Personal communication. Meeting with MDEQ, Sept., 1997.

Alexander, M. 1991. Introduction to soil microbiology. Kriegar Pub. Co., Malabar, FL. 467 pp.

Ballek, L. 1996. Wetland restoration with container-grown plants. pp. 193-194 *In*: Proceedings from Planning, Rehabilitation and Treatment of Disturbed Lands, Seventh Billings Symposium, March 17-23.

Bluhm, W. 1992. Basic principles for establishing native grasses. Hortus Northwest 3 (reprint does not indicate pages as published).

Briggs, M., Roundy, B., and W. Shaw. 1995. Trial and error. Restoration and Management Notes 12: 160-166.

Brinkman, K. 1974: *Salix* L. willow. pp. 746-750 *In:* Schopmeyer, C. S. tech. coord. Seeds of woody plants in the United States. U. S. Agric. Handbk. 450. Wash., D.C. USDA Forest Service.

Brunsfeld, S., and F. Johnson. 1985. Field guide to the willows of east-central Idaho. Univ. of Idaho, Forest, Wildlife and Range Expt. Sta. Bull. No. 39.

Carlson, R. 1998. Mr. Carlson is Weed Control Supervisor for Butte-Silver Bow. February.

Carlson, J., Conaway, G., Gibbs, J., and J. Hoag. 1991. Design criteria for revegetation in riparian zones of the intermountain area. pp. 145-150 In: Proceedings – Symposium Ecology and Management of Riparian Shrub Communities. USDA For. Ser. Gen. Tech. Rep. RM-65. Rocky Mtn. For. & Range Expt. Sta., Fort Collins, CO.

Christensen, M., and W. Williams. 1977. Occurrence of vesicular-arbuscular mycorrhizae on shrubs and grasses in strip-mine regions of Wyoming. Abstract *In:* Proceedings of the North American Conference on Mycorrhizae. Atlanta. August.

Clark, D. 1991. The effect of fire on Yellowstone ecosystem seed banks. Unpublished masters thesis, Montana State University. -- pp.

Conroy, S., and T. Svejcar. 1991. Willow planting success as influenced by site factors and cattle grazing in northeastern California. J. Range Mgt. 44(1): 59-63.

Cresswell, E., and J. Grime. 1981. Induction of a light requirement during seed development and its ecological consequences. Nature 291: 583-585.

Daniels, D., and J. Menge. 1981. Evaluation of the commercial application of the vesicular arbuscular mycorrhizal fungus *Glomus epigaeus*. The New Phytologist 87: 345-354.

Daubenmire, R. 1968. Plant communities: a textbook of plant synecology. Harper and Row, N.Y. 300 pp.

Environmental Laboratory. 1987. Corps of Engineers. Wetlands delineation manual. Tech. Rept. Y-87-1. U.S. Army Engineer Waterways Expt. Sta. Vicksburg, Miss. 100 pp. + appendices.

Federal Interagency Committee for Wetland Delineation (FICWD). 1989. Federal manual for identifying and delineating jurisdictional wetlands. U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and USDA. Soil Conservation Service, Washington, D.C. Cooperative technical publication. 76 pp. + appendices.

Gomm, F. 1969. Evaluations of grasses, legumes and grass-legume mixtures for irrigated pastures grazed by sheep under various fertility and management practices. Mt. Ag. Expt. Sta. — MSU Bull. 618. 34 pp.

Goodrich, S. 1991. Summary flora of riparian shrub communities of the intermountain region with emphasis on willows. pp. 62-67 *In*: Proc. Sym. on Ecology and Management of Riparian Shrub Communities. Sun Valley, ID. May 29-31.

Groff, D. 1994. Revegetating disturbed mineral soils. Hortus Northwest 5(1) (reprint does not indicate pages as published).

Groff, D. 1992. Vegetative growth habits of sedges. Hortus Northwest 3 (reprint does not indicate pages as published)

Green, M., Safray, I., and M. Agami. 1996. Constructed wetlands for river reclamation: experimental design, start-up and preliminary results. Bioresource Tech. 55: 157-162.

Hammer, D. 1997. Creating freshwater wetlands (second ed.). CRC Press/Lewis Publishers. Boca Raton, FL. 406 pp.

Hoag, J. Chris. 1998. Personal communication. Mr. Hoag is a wetland plant ecologist, USDA - NRCS. Plant Materials Center, Aberdeen, ID.

Hoag, J. 1994. How to plant willows and cottonwood dormant pole cuttings for riparian rehabilitation. Riparian/Wetland Project Information Series No. 4. Contact USDA NRCS Plant Materials Center, Aberdeen, ID, 83210.

Hoag, J. 1993a. Selection and acquisition of woody plant species and materials for riparian corridors and shorelines. Riparian/Wetland Project Information Series No. 2. Contact USDA NRCS Plant Materials Center, Aberdeen, ID, 83210.

Hoag, J. 1993b. How to plant willows and cottonwoods for riparian rehabilitation. Tech. Note Plant Materials No. 23. Contact USDA NRCS Plant Materials Center, Aberdeen, ID, 83210.

Hoag, J. 1991. Planting techniques from the Aberdeen, ID, plant materials center for vegetating shorelines and riparian areas. pp. 163-166 In: Proceedings – Symposium Ecology and Management of Riparian Shrub Communities. USDA For. Ser. Gen. Tech. Rep. RM-65. Rocky Mtn. For. & Range Expt. Sta., Fort Collins, CO.

Hoag, J., and M. Sellers. 1995. View from a Wetland No. 2. News and Technology for Riparian and Wetland Management. Contact USDA NRCS Plant Materials Center, Aberdeen, ID, 83210.

Hoag, J., Sellers, M., and M. Zierke. 1994. View from a Wetland No. 1. News and Technology for Riparian and Wetland Management. Contact USDA NRCS Plant Materials Center, Aberdeen, ID, 83210.

Houlton, H. 1974. Range vegetation response to nitrogen fertilization in north central Montana. pp. 64-79 *In*: Proc. Range Fertilization Symposium, Havre, MT. July. Mt. Ag. Expt. Sta. Res. Rep. 70. 109 pp. but pages not consecutively numbered.

Ingham, E. 1998. Personal communication. Ms. Ingham holds a doctorate in soil microbiology and is a principal at Soil Foodweb Inc., Corvallis, OR.

Insam, H. No date on copy. Soil microbiological properties of reclamation sites compared to natural succession. Citation lacking.

Iverson, L., and M. Wali. 1982. Reclamation of coal-mined lands: the role of *Kochia scoparia* and other pioneers in early succession. Reclamation and Revegetation. Res. 1: 123-160.

Jacobsen, J. 1998. Personal communication. Mr. Jacobsen is interim department head for the MSU Soil, Plant, and Environmental Science Department, Bozeman, MT.

Jensen, B. 1997. Personal communication. Mr. Jensen runs a revegetation service and has wide experience in the Butte-Anaconda area.

Johnson, N., and A. McGraw. 1988. Vesicular-arbuscular mycorrhizae in taconite tailings. I. Incidence and spread of endogonaceous fungi following reclamation. Agriculture, Ecosystems and Environment 21: 135-142.

Jones, H. 1983. Plants and microclimate. Cambridge Univ. Press, Cambridge.

Keck, T. 1997. Mr. Keck holds a doctorate in soil science and is project leader, Silver Bow Soil Survey, USDA-NRCS, Whitehall Office.

Kilcher, M., Smoliak, S., Hubbard, W., Johnston, A., Gross, A., and E. McCurdy. 1965. Effects of inorganic nitrogen and phosphorus fertilizers on selected sites of native grassland in western Canada. Can. J. Plant Sci. 45: 229-237.

Kleinman, L. 1996. Transplanting live plants and planting plant parts. pp. V-41-44 *In*: Wyoming Department of Environmental Quality and USDI Office of Surface Mining. Cited elsewhere.

Kludze, H., and R. DeLaune. 1996. Soil redox intensity effects on oxygen exchange and growth of cattail and sawgrass. Soil Sci. Soc. Am. J. 60: 616-621.

Kuchler, A. 1967. Vegetation mapping. The Ronald Press Co., New York, NY. 472 pp.

Ladd, J. N. 1985. Soil enzymes. pp. 175-221 *In:* D. Vaughn and R. Malcom (eds.). Soil organic matter and biological activity. Martinus Nijhoff, Drodrecht, The Netherlands.

Leonard, S., Staidl, G., Gebhardt, K., and D. Prichard. 1992. Viewpoint: Range site/ecological site information requirements for classification of riverine riparian ecosystems. J. Range Mgt. 45: 431-435.

Levine, D., and D. Willard. 1990. Regional analysis of fringe wetlands in the Midwest: creation and restoration. pp. 299-325 *In:* J. A. Kusler and M. E. Kentula (eds.). Wetland Creation and Restoration: The Status of the Science. Island Press, Wash., DC.

Linder, G., Henderson, G., and E. Ingham. 1996b. Metal toxicity in the rhizosphere. Part 2: Improving soil tilth and plant nutrition to enhance revegetation of disturbed mining lands of the western United States. Hortus Northwest, 7(1) (reprint does not indicate page numbers as published).

Linderman, R. 1994. Role of VAM in biocontrol. pp. 1-26 *In:* F. L. Pfleger and R. Linderman (eds.) Mycorrhizae and Plant Health. APS Press, St. Paul.

Meyer, S., and S. Kitchen. 1995. First the seed: A restorationist's perspective. Hortus Northwest 6 (2) (reprint does not indicate page numbers as published).

Miller, R. 1987. Mycorrhizae and succession. pp. 205-219 *In:* Restoration Ecology: A synthetic approach to ecological research. W. Jordan, M. Gilpin, & J. Aber (eds.). Cambridge University Press, Cambridge.

Miller, R., and J. Jastrow. 1992. Applications of VA mycorrhizae to ecosystem restoration. pp. 438-467 IN: Mycorrhizal Functioning: An Integrative Plant-Fungal Process. M.F. Allen (ed.).

Mueggler, W., and J. Blaisdell. 1955. Effect of seeding rate upon establishment and yield of crested wheatgrass. J. Range Mgt. 8(2): 74-76.

National Research Council. 1995. Wetlands, characteristics and boundaries. W. Lewis Chair. National Academy Press (National Academy of Sciences). ISBN 0-309-05134. 307 pp.

Newman, E. 1988. Mycorrhizal links between plants: Their functioning and ecological significance. Advances in Ecological Research 18: 243-270.

Noon, K. 1996. A model of created wetland primary succession. Landscape and Urban Planning 34 (2): 97-123.

Patten, D. 1968. Dynamics of the shrub continuum along the Gallatin River in Yellowstone National Park. Ecol. 49(6): 1107-1112.

Perry, D., and M. Amaranthus. 1991. The plant-soil bootstrap: Microorganisms and reclamation of degraded ecosystems. pp. 94-102 *In*: J. Berger (ed.). Environmental Restoration, Science and Strategies for Restoring the Earth. Island Press. Washington, D.C.

Perry, D., Amaranthus, J., Borchers, J., Borchers, S., and R. Brainerd. 1989. Bootstrapping in ecosystems. BioScience 39: 230-237.

Perry, D., Molina, R., and M. Amaranthus. 1987. Mycorrhizae, mycorrhizospheres and reforestation: Current knowledge and research needs. Canadian J. Forest Research 17: 929-940.

Plantenberg, P. 1997. Personal communication at revegetation peer review meeting. Mr. Plantenberg is a vegetation specialist at MDEQ, Hard Rock Bureau.

Planty-Tabacchi, A., Tabacchi, E., Naiman, J., Deferrari, C., and H. DeCamps. 1996. Conservation Biology 10: 598-607.

Platts, W., Armour, C., Booth, G., Bryant, M., Bufford, J., Cuplin, P., Jensen, S., Lienkaemper, G., Minshall, G., Monsen, S., Nelson, R., Sedell, J., and J. Tuhy. 1987. Methods for evaluating riparian habitats with applications to management. USDA For. Ser. IRS Gen. Tech. Rept. INT-221.

Prodgers, R. 1999. Butte Hill revegetation monitoring 1998. Prepared for the Butte-Silver Bow Planning Dept. 35 pp. + appendices.

Prodgers, R. 1998a. Butte Hill revegetation monitoring 1997. Prepared for the Butte-Silver Bow Planning Dept., Jan. 1998. 35 pp. + appendices.

Prodgers, R. 1998b. Evaluating compost for the SST OU. Memo to MDEQ. March.

Prodgers, R. 1988. Predicting peak standing crop of some grassland plant communities in Montana. Proc. MT Acad. Sci. 48: 105-111.

Prodgers, R., and T. Keck. 1996. Vegetational diversity concepts and strategies for reclamation. pp. 141-157 *In:* Proceedings from Planning, Rehabilitation and Treatment of Disturbed Lands, Seventh Billings Symposium. March 17-23.

Reeder, J. 1990. Nitrogen cycling in disturbed lands. pp. 122-137 *In:* Proceedings High Altitude Revegetation Workshop No. 9. July. Co. St. Univ. – Co. Water Resource Research Inst. Information Series No. 63. 257 pp.

Reeder, J., and B. Sabey. 1987. Nitrogen. pp. 155-184 *In:* D. Wiliams and B. Schuman (eds.) Reclaiming Mine Soils and Overburdens in Western United States: Analytical Parameters and Procedures. Soil. Conserv. Soc. Amer., Ankeny, Iowa.

Reeder, J., and W. Berg. 1977a. Nitrogen mineralization and nitrification in a Cretaceous shale and coal mine spoils. Soil Sci. Soc. Am. J. 42: 922-927.

Reeder, J., and W. Berg. 1977b. Plant uptake of indigenous and fertilizer nitrogen from a Cretaceous shale and coal mine spoils. Soil Sci. Soc. Am. J. 41: 919-921.

Reeves, F., Wagner, D., Moorman, T., and Kiel, J. 1979. The role of endomycorrhizae in revegetation practices in the semi-arid west. American J. of Botany 66 (1): 6-13. CHECK YEAR–1979 OR 1977???

Reinartz, J., and E. Warne. 1993. Development of vegetation in small created wetlands in southeastern Wisconsin. Wetlands 13(3): 153-164.

Rosales, J, Cuenca, G., Ramirez, N., Z. De Andrade. 1997. Native colonizing species and degraded land restoration in La Gran Sabana, Venezuela. Restoration Ecology 5(2): 147-155.

Ryerson, D., and J. Taylor. 1974. Rangeland fertilization in Montana - A literature review. pp. 1-19 *In:* Proc. Range Fertilization Symposium, Havre, MT. July. Mt. Ag. Expt. Sta. Res. Rep. 70. Pages not consecutively numbered.

St. John, T. 1998. Mycorrhizal inoculation in habitat restoration. Land and water Sept./Oct. Pp. 17-19.

St. John, T., Dixon, R., and M. St. John. 1997. Restoring Arizona's Discovery Park. Hortus Northwest 8(2): 16-17, 56, 58.

St. John, T. 1996. Mycorrhizal inoculation: Advice for growers & restorationists. Hortus West 7(2). Pages not listed in reprint.

St. John, T., Coleman, D., and C. Reid. 1983. Growth and spatial distribution of nutrient-absorbing organs: Selective exploitation of soil heterogeneity. Plant and Soil Sci. 71: 487-493.

Sansen, U., and N. Koedam. 1996. Use of sod cuttings for restoration of wet heathlands: Revegetation and establishment of typical species in relation to soil conditions. J. Veg. Sci. 7: 483-486.

Smith, L., and J. Kadlec. 1983. Seed banks and their role during March drawdown of a North American marsh. J. Applied Ecol. 20: 673-684.

Soil Conservation Service (SCS, now the Natural Resource Conservation Service). 1991. Hydric soils of the United States. USDA SCS Misc. Pub. 1491. Pages unnumbered.

Steinbacher, J. 1997. Erosion control demonstration project, Horseshoe Bend Hill, Idaho State Highway 55. Prepared for Idaho Trans. Dept. and Fed. Hwy. Admin. 11 pp.

Tabacchi, E., Planty-Tabacchi, A.M., Salinas, M.J., and H. DeCamps. 1996. Landscape structure and diversity in riparian plant communities: A longitudinal comparative study. Regulated Rivers Research and Management 12(4-5): 367-390.

Turner,S., and C. Friese. 1998. Plant-mycorrhizal community dynamics associated with a moisture gradient within a rehabilitated prairie fen. Turner, S., and C. Friese. Restoration Ecology 6(1):44-51.

van der Valk, A., and C. Davis. 1978. The role of seed banks in the vegetation dynamic of prairie glacial marshes. Ecology 59(2): 322-335.

Walker, L. and F. Chapin. 1986. Comparative studies of plant growth and distribution in relation to water-logging. The New Phytologist. April: 575-583.

Weiher, E., Wisheu I., Keddy, P., and D. Moore. 1996. Establishment, persistence, and management implications of experimental wetland plant communities. Wetlands 16(2): 208-218.

Wight, J. 1974. A summary of range fertilization research conducted by the Northern Plains Soil and Water Research Center. Pp. 100-109 *In:* Proc. Range Fertilization Symposium, Havre, MT. July. Mt. Ag. Expt. Sta. Res. Rep. 70. 109 pp. but pages not consecutively numbered.

Wilson, M. 1991. An introduction to wetland plant communities in western Oregon. Hortus Northwest 2 (reprint does not indicate pages as published).

Wyoming Department of Environmental Quality and USDI Office of Surface Mining. 1996. Handbook of western reclamation techniques. Numerous contributors, editors for each section. Available from the Office of Technology Transfer, Western Regional Coordinating Center, Office of Surface Mining Reclamation and Enforcement, 1999 Broadway, Suite 3320, Denver, CO, 80202-5733.

Zak, B. 1971. Dexotication of autoclaved soil by a mycorrhizal fungus. USDA Forest Service Res. Note PNW-159. 4 pp.

Ziemkiewicz, P., and S. Takyi. 1990. Organic matter dynamics on reclaimed coal mines in the Canadian Rockies. pp. 127-133 *In:* Proc. of the 1990 Mining and Reclamation Conference and Exhibition, Vol. I. Charleston, W. Va. 319 pp.

APPENDIX K

RAILROAD MATERIALS REMEDIATION

Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

APPENDIX K-1

Design Calculations for Off-Site Sediment Basins

MAXIM TECHNOLOGIES INC

BY G. FISCHER DATE 12/29/97

JOB TITLE SST - RR Materials JOB NUMBER 9731701 - 190

SUBJECT Runoff from Non-Priority Soils SHEET 1 of 7

SEDIMENT BASINS FOR NON-PRIORITY SOILS AREAS

BASIN FROM AREAS C12 & C13 (see map)

- chosen because map shows culvert under Interstate 90, which contributes more drainage area.
- this is an example to estimate size of basin needed
- use 10-yr, 24 hr storm for design

DA ≅ 1000 Ft x 5000 ft = 0.18 sm

Mean Annual Precip = MAP ≅ 12 inches

Location: long = 112.35°
lat = 46.0°

Ref for Rainfall: USGS Water Resources Investigations Report 97-4004
Regional Analysis of Annual Precip. Maxima in Montana

Total Rainfall for 10-yr, 24-hr storm = 1.51 inches
(see spreadsheet)

Hyetograph from prelim USGS data for rainfall distribution
(see spreadsheet)

From HEC-1 modeling, (see model printout) ROCKER1.HC1

Total excess runoff = 0.17 inches

Total runoff ≅ 2 ac-ft

Approx Basin size: (For capture of storm runoff)

150' x 150' x 4 ft deep

BASIN FROM AREAS C2, C3, & C4

- chosen to represent areas which don't have contribution from north of the Interstate (no culvert under Interstate)

DA ≅ 550 x 1100 = 0.022 sum

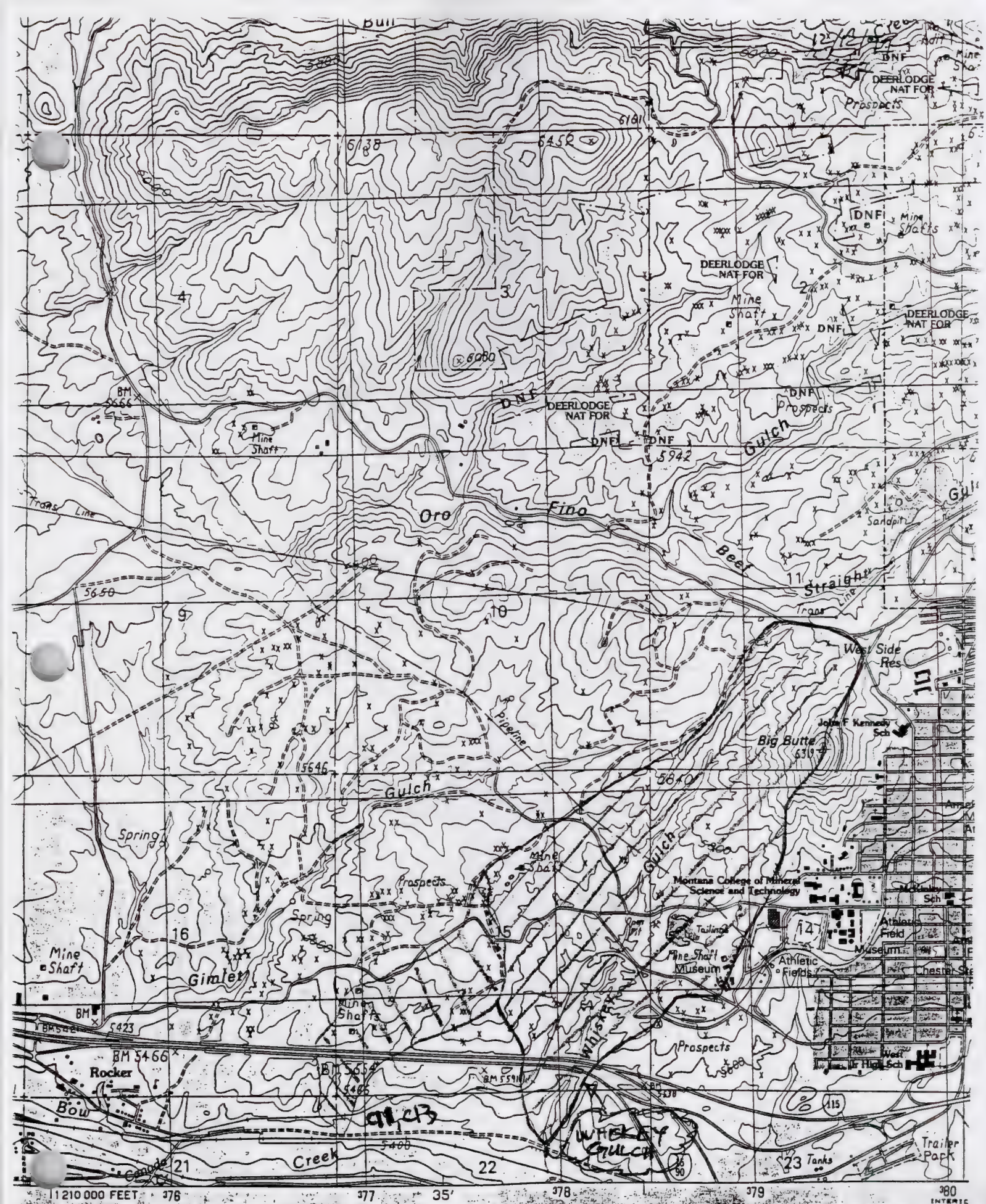
same input for HEC-1 model as previous example

The HEC-1 model (ROCKER2.HC1) shows no runoff volume because of rounding.

However, 0.17 inches excess over 0.022 sum equals ~ 8700 cf basin, or a size of

50' x 50' x 4 ft deep

(For capture of storm runoff)



1:210 000 FEET

SCALE 1:24 000

5 0 KILOMETERS 1

1000 0 METERS 1000

5 0 MILES

NORTH

EOLOGICAL SURVEY

. . . . . USGS, NOS/NOAA

. 1954-1956

. 1959

EN 1965

ED 1969

ST CONFORMAL CONIC

Estimate of Mean Precipitation Maxima for a Drainage Basin G. Fischer, DNRC, 4/29/97 File: EXTPCPBN.WB2

From Parrett, USGS Water-Resources Investigations Report 97-4004, Regional Analysis of Annual Precipitation Maxima in Montana, 19975.

Fill in values which are bold type.

Enter the basin or site description: Rocker - c12/c13

Enter the storm duration in hours: 24

Enter the storm recurrence interval in years: 10

Region 1 Quantile = 1.4514104613832
Region 2 Quantile = 1.5243851200156
Region 3 Quantile = 1.5450954903955

Basin area in square miles: 0.18

Point	Region Number	Dimensionless Regional Quantile	Latitude (decimal degrees)	LAT (latitude - 40)	Longitude (decimal degrees)	LONG (longitude - 100)	Mean Annual Precip (MAP) (inches)	Region 1 Pmax2	Region 1 Pmax6	Region 1 Pmax24	Region 2 Pmax2	Region 2 Pmax6	Region 2 Pmax24	Region 3 Pmax2	Region 3 Pmax6	Region 3 Pmax24	Basin Areal Reduction Factor	2-hr Total Depth (inches)	6-hr Total Depth (inches)	24-hr Total Depth (inches)
1	1	1.45	48	8	112.35	12.35	12			1.04							1			1.51
2																				
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Sum of Total Precipitation Values	0.00	0.00	1.51
Total Basin Average Precipitation Depth (inches) =	**ERR (2-hour)**	**ERR (6-hour)**	**1.51 (24-hour)**

Sheet 26 of 47
12/29/97
GRF

Sht 2c of 7

24-hour total precipitation value from page Basinavgdepth = 1.51 inches

use this hyetograph 12/29/9. GRF

Incremental Rainfall Depths - Long-Duration Storm

region 1 peak median	region 1 peak design	region 1 volume median	region 1 volume design	region 2 peak median	region 2 peak design	region 2 volume median	region 2 volume design
0.009	0.004	0.006	0.015	0.004	0.003	0.003	0.006
0.009	0.004	0.006	0.015	0.004	0.003	0.003	0.006
0.009	0.004	0.006	0.015	0.007	0.003	0.006	0.015
0.009	0.004	0.006	0.015	0.007	0.005	0.006	0.015
0.009	0.004	0.027	0.037	0.007	0.005	0.006	0.015
0.009	0.004	0.027	0.037	0.007	0.005	0.006	0.015
0.009	0.004	0.027	0.037	0.007	0.005	0.006	0.015
0.009	0.004	0.048	0.046	0.007	0.005	0.006	0.015
0.009	0.004	0.048	0.046	0.014	0.005	0.011	0.022
0.009	0.004	0.048	0.046	0.014	0.005	0.011	0.022
0.030	0.004	0.049	0.053	0.014	0.005	0.011	0.022
0.030	0.004	0.049	0.053	0.014	0.005	0.011	0.022
0.030	0.004	0.056	0.062	0.014	0.005	0.011	0.022
0.030	0.004	0.081	0.072	0.014	0.009	0.011	0.022
0.030	0.005	0.081	0.072	0.033	0.009	0.031	0.038
0.030	0.005	0.136	0.119	0.033	0.009	0.031	0.038
0.049	0.005	0.235	0.207	0.033	0.009	0.031	0.038
0.049	0.005	0.124	0.110	0.033	0.009	0.047	0.045
0.060	0.005	0.081	0.072	0.046	0.009	0.047	0.045
0.078	0.005	0.056	0.062	0.046	0.009	0.047	0.045
0.078	0.005	0.056	0.062	0.061	0.009	0.062	0.058
0.226	0.005	0.049	0.053	0.061	0.009	0.062	0.058
0.131	0.005	0.048	0.046	0.072	0.009	0.071	0.075
0.118	0.005	0.048	0.046	0.072	0.023	0.074	0.082
0.078	0.005	0.048	0.046	0.076	0.023	0.074	0.082
0.060	0.005	0.027	0.037	0.076	0.023	0.121	0.106
0.060	0.020	0.027	0.037	0.186	0.023	0.193	0.161
0.049	0.020	0.027	0.037	0.116	0.023	0.107	0.095
0.049	0.020	0.006	0.015	0.104	0.023	0.074	0.082
0.049	0.020	0.006	0.015	0.076	0.040	0.071	0.075
0.049	0.041	0.006	0.015	0.072	0.040	0.071	0.075
0.049	0.045	0.006	0.015	0.061	0.040	0.062	0.058
0.049	0.045	0.006	0.015	0.046	0.040	0.047	0.045
0.049	0.045	0.006	0.015	0.046	0.040	0.047	0.045
0.009	0.049	0.006	0.015	0.046	0.058	0.047	0.045
0.009	0.049	0.006	0.015	0.046	0.058	0.031	0.038
0.006	0.088	0.003	0.008	0.033	0.079	0.031	0.038
0.006	0.088	0.003	0.008	0.033	0.079	0.031	0.038
0.006	0.137	0.003	0.008	0.014	0.081	0.011	0.022
0.006	0.163	0.003	0.008	0.014	0.081	0.011	0.022
0.006	0.294	0.003	0.008	0.014	0.081	0.011	0.022
0.006	0.088	0.003	0.008	0.014	0.113	0.011	0.022
0.006	0.049	0.003	0.008	0.014	0.134	0.011	0.022
0.006	0.041	0.003	0.008	0.014	0.226	0.011	0.022
0.006	0.041	0.003	0.008	0.007	0.079	0.006	0.015
0.006	0.041	0.003	0.008	0.007	0.058	0.006	0.015
0.006	0.041	0.003	0.008	0.007	0.040	0.006	0.015
0.006	0.041	0.003	0.008	0.007	0.009	0.006	0.015
0.005	0.020	0.003	0.007	0.007	0.009	0.006	0.015
0.005	0.020	0.003	0.007	0.007	0.005	0.006	0.015
0.005	0.004	0.003	0.007	0.004	0.005	0.003	0.006
0.005	0.004	0.003	0.007	0.004	0.003	0.003	0.006
0.005	0.004	0.003	0.007	0.004	0.003	0.003	0.006
0.005	0.004	0.003	0.007	0.004	0.003	0.003	0.006
0.005	0.004	0.003	0.007	0.004	0.003	0.003	0.006
0.005	0.004	0.003	0.007	0.004	0.003	0.003	0.006
0.005	0.004	0.003	0.007	0.004	0.003	0.003	0.006
0.005	0.004	0.003	0.007	0.004	0.003	0.003	0.006
0.005	0.004	0.003	0.007	0.004	0.003	0.003	0.006
0.004	0.003	0.003	0.007	0.003	0.003	0.002	0.004
0.004	0.003	0.003	0.007	0.003	0.003	0.002	0.004
0.004	0.003	0.003	0.007	0.003	0.003	0.002	0.004
0.004	0.003	0.003	0.007	0.003	0.003	0.002	0.004
0.004	0.003	0.003	0.007	0.003	0.003	0.002	0.004
0.004	0.003	0.003	0.007	0.003	0.003	0.002	0.004
0.004	0.002	0.003	0.007	0.003	0.003	0.002	0.004
0.004	0.002	0.003	0.007	0.003	0.003	0.002	0.004
0.004	0.002	0.003	0.007	0.003	0.003	0.002	0.004
0.004	0.002	0.003	0.007	0.003	0.003	0.002	0.004
0.004	0.002	0.003	0.007	0.003	0.003	0.002	0.004
		1.50					
1.804	1.698	~~1.875~~	1.946	1.845	1.748	1.773	2.073

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*          SEPTEMBER 1990               *
*           VERSION 4.0                 *
*                                       *
*  RUN DATE  12/29/1997  TIME  14:32:55 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*        609 SECOND STREET              *
*     DAVIS, CALIFORNIA 95616           *
*         (916) 756-1104                *
*                                       *
*****************************************
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```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX          XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

```
          LINE  ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
            1   ID   RUNOFF FROM NON-PRIORITY SOIL AREA EAST OF ROCKER     FILE:ROCKER1.HC1
            2   ID   CONTRIBUTING AREA ABOVE RR MATLS C12/C13, CULVERT UNDER INTERSTATE
            3   ID   10-YR, 24-HR STORM
            4   ID   PRECIP ESTIMATES FROM PRELIMINARY USGS RESULTS, 1995
            5   ID   DIMENSIONLESS UNIT GRAPH FROM USGS (AVG GRAPH); INFILTRATION ESTIMATED
            6   ID   G. FISCHER, MAXIM, 12/29/97
*** FREE ***
            7   IT     10                    160
            8   IN     60
            9   IO      1       0
                * JR  FLOW     1.0   0.895

           10   KK  INFLOW   INFLOW INTO SEDIMENT BASIN
           11   BA    0.18
           12   BF    0.01    0.01      1
           13   PI    .027    .027    .027    .048    .048    .048    .049    .049    .056    .081
           14   PI    .081    .136    .235    .124    .081    .056    .056    .049    .048    .048
           15   PI    .048    .027    .027    .027
           16   LS       0      75    0.05
           17   UC   0.098     2.0
                * KK   OUT   OUTFLOW FROM DRY FORK DAM
                * RS     1   ELEV  2484.0
                * SQ     0      74     116     228     437     540     642     744
                * SE2485.0   2487  2489.8  2491.5  2492.9  2493.5  2494.0  2494.4
                * SV     0     400    1520    3820    7500    8260    9210
                * SE  2450   2460    2470    2480    2490    2492  2494.5
                * ST2494.5   1300     2.6     1.5
                *
                * **
                *
           18   ZZ
```

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*          SEPTEMBER 1990               *
*           VERSION 4.0                 *
*                                       *
*  RUN DATE  12/29/1997  TIME  14:32:55 *
*                                       *
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*     DAVIS, CALIFORNIA 95616           *
*         (916) 756-1104                *
*                                       *
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```

RUNOFF FROM NON-PRIORITY SOIL AREA EAST OF ROCKER FILE:ROCKER1.HC1
CONTRIBUTING AREA ABOVE RR MATLS C12/C13, CULVERT UNDER INTERSTATE
10-YR, 24-HR STORM
PRECIP ESTIMATES FROM PRELIMINARY USGS RESULTS, 1995
DIMENSIONLESS UNIT GRAPH FROM USGS (AVG GRAPH); INFILTRATION ESTIMATED
G. FISCHER, MAXIM, 12/29/97

```
  9 IO          OUTPUT CONTROL VARIABLES
                     IPRNT          1  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                     NMIN          10  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1    0  STARTING DATE
                    ITIME        0000  STARTING TIME
                       NQ         160  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE     2    0  ENDING DATE
                    NDTIME       0230  ENDING TIME
                    ICENT          19  CENTURY MARK

                  COMPUTATION INTERVAL      .17 HOURS
                      TOTAL TIME BASE   26.50 HOURS

        ENGLISH UNITS
             DRAINAGE AREA          SQUARE MILES
             PRECIPITATION DEPTH    INCHES
             LENGTH, ELEVATION      FEET
             FLOW                   CUBIC FEET PER SECOND
             STORAGE VOLUME         ACRE-FEET
             SURFACE AREA           ACRES
             TEMPERATURE            DEGREES FAHRENHEIT
```

sht 2e of 7
12/29/97
GRF

*** ***

```
          **************
          *            *
10 KK     *   INFLOW   *       INFLOW INTO SEDIMENT BASIN
          *            *
          **************

 8 IN       TIME DATA FOR INPUT TIME SERIES
                 JXMIN          60  TIME INTERVAL IN MINUTES
                JXDATE      1   0  STARTING DATE
                JXTIME          0  STARTING TIME

          SUBBASIN RUNOFF DATA

11 BA       SUBBASIN CHARACTERISTICS
                 TAREA        .18  SUBBASIN AREA

12 BF       BASE FLOW CHARACTERISTICS
                 STRTQ        .01  INITIAL FLOW
                 QRCSN        .01  BEGIN BASE FLOW RECESSION
                 RTIOR    1.00000  RECESSION CONSTANT

            PRECIPITATION DATA

11 PB            STORM       1.50  BASIN TOTAL PRECIPITATION

11 PI         INCREMENTAL PRECIPITATION PATTERN
                .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
                .00    .00    .00    .00    .00    .00    .00    .00    .01    .01
                .01    .01    .01    .01    .01    .01    .01    .01    .01    .01
                .01    .01    .01    .01    .01    .01    .01    .01    .01    .01
                .01    .01    .01    .01    .01    .01    .01    .01    .01    .01
                .01    .01    .01    .01    .01    .01    .01    .01    .01    .01
                .01    .01    .01    .01    .01    .01    .02    .02    .02    .02
                .02    .02    .04    .04    .04    .04    .04    .04    .02    .02
                .02    .02    .02    .02    .01    .01    .01    .01    .01    .01
                .01    .01    .01    .01    .01    .01    .01    .01    .01    .01
                .01    .01    .01    .01    .01    .01    .01    .01    .01    .01
                .01    .01    .01    .01    .01    .01    .01    .01    .01    .01
                .01    .01    .01    .01    .01    .01    .01    .00    .00    .00
                .00    .00    .00    .00    .00    .00    .00    .00    .00    .00
                .00    .00    .00    .00

16 LS       SCS LOSS RATE
                 STRTL         .67  INITIAL ABSTRACTION
                CRVNBR       75.00  CURVE NUMBER
                 RTIMP         .05  PERCENT IMPERVIOUS AREA

17 UC       CLARK UNITGRAPH
                   TC         .10  TIME OF CONCENTRATION
                    R        2.00  STORAGE COEFFICIENT

            SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                                  ***

TC INCREASED TO DELTA T OF   .17 HR

                                  UNIT HYDROGRAPH PARAMETERS
                              CLARK   TC=    .17 HR,      R=  2.00 HR
                             SNYDER   TP=    .29 HR,     CP=   .15

                                    UNIT HYDROGRAPH
                                65 END-OF-PERIOD ORDINATES
          28.     54.     49.     45.     42.     38.     35.     32.     30.     27.
          25.     23.     21.     20.     18.     17.     15.     14.     13.     12.
          11.     10.      9.      9.      8.      7.      7.      6.      6.      5.
           5.      4.      4.      4.      3.      3.      3.      3.      2.      2.
           2.      2.      2.      2.      1.      1.      1.      1.      1.      1.
           1.      1.      1.      1.      1.      1.      1.      1.      0.      0.
           0.      0.      0.      0.      0.
```

****

HYDROGRAPH AT STATION INFLOW

****

DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q	DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
1		0000	1	.00	.00	.00	0.	1		1320	81	.02	.02	.00	1.
1		0010	2	.00	.00	.00	0.	1		1330	82	.02	.02	.00	1.
1		0020	3	.00	.00	.00	0.	1		1340	83	.02	.02	.00	1.
1		0030	4	.00	.00	.00	0.	1		1350	84	.02	.02	.00	1.
1		0040	5	.00	.00	.00	0.	1		1400	85	.02	.02	.00	1.
1		0050	6	.00	.00	.00	0.	1		1410	86	.01	.01	.00	1.
1		0100	7	.00	.00	.00	0.	1		1420	87	.01	.01	.00	1.
1		0110	8	.00	.00	.00	0.	1		1430	88	.01	.01	.00	2.
1		0120	9	.00	.00	.00	0.	1		1440	89	.01	.01	.00	2.
1		0130	10	.00	.00	.00	0.	1		1450	90	.01	.01	.00	2.
1		0140	11	.00	.00	.00	0.	1		1500	91	.01	.01	.00	2.
1		0150	12	.00	.00	.00	0.	1		1510	92	.01	.01	.00	2.
1		0200	13	.00	.00	.00	0.	1		1520	93	.01	.01	.00	2.
1		0210	14	.00	.00	.00	0.	1		1530	94	.01	.01	.00	2.
1		0220	15	.00	.00	.00	0.	1		1540	95	.01	.01	.00	2.
1		0230	16	.00	.00	.00	0.	1		1550	96	.01	.01	.00	2.
1		0240	17	.00	.00	.00	0.	1		1600	97	.01	.01	.00	2.
1		0250	18	.00	.00	.00	0.	1		1610	98	.01	.01	.00	2.
1		0300	19	.00	.00	.00	0.	1		1620	99	.01	.01	.00	2.
1		0310	20	.01	.01	.00	0.	1		1630	100	.01	.01	.00	2.
1		0320	21	.01	.01	.00	0.	1		1640	101	.01	.01	.00	2.
1		0330	22	.01	.01	.00	0.	1		1650	102	.01	.01	.00	2.
1		0340	23	.01	.01	.00	0.	1		1700	103	.01	.01	.00	2.
1		0350	24	.01	.01	.00	0.	1		1710	104	.01	.01	.00	2.
1		0400	25	.01	.01	.00	0.	1		1720	105	.01	.01	.00	2.
1		0410	26	.01	.01	.00	0.	1		1730	106	.01	.01	.00	2.
1		0420	27	.01	.01	.00	0.	1		1740	107	.01	.01	.00	2.
1		0430	28	.01	.01	.00	0.	1		1750	108	.01	.01	.00	2.
1		0440	29	.01	.01	.00	0.	1		1800	109	.01	.01	.00	2.
1		0450	30	.01	.01	.00	0.	1		1810	110	.01	.01	.00	2.
1		0500	31	.01	.01	.00	0.	1		1820	111	.01	.01	.00	2.
1		0510	32	.01	.01	.00	0.	1		1830	112	.01	.01	.00	2.
1		0520	33	.01	.01	.00	0.	1		1840	113	.01	.01	.00	2.
1		0530	34	.01	.01	.00	0.	1		1850	114	.01	.01	.00	2.
1		0540	35	.01	.01	.00	0.	1		1900	115	.01	.01	.00	2.

Sht 2 of 7
12/29/97
GRF

1	0550	36	.01	.01	.00	0.	*	1	1910	116	.01	.01	.00	2.
1	0600	37	.01	.01	.00	0.	*	1	1920	117	.01	.01	.00	2.
1	0610	38	.01	.01	.00	0.	*	1	1930	118	.01	.01	.00	2.
1	0620	39	.01	.01	.00	0.	*	1	1940	119	.01	.01	.00	2.
1	0630	40	.01	.01	.00	0.	*	1	1950	120	.01	.01	.00	2.
1	0640	41	.01	.01	.00	0.	*	1	2000	121	.01	.01	.00	2.
1	0650	42	.01	.01	.00	0.	*	1	2010	122	.01	.01	.00	2.
1	0700	43	.01	.01	.00	0.	*	1	2020	123	.01	.01	.00	2.
1	0710	44	.01	.01	.00	0.	*	1	2030	124	.01	.01	.00	2.
1	0720	45	.01	.01	.00	0.	*	1	2040	125	.01	.01	.00	2.
1	0730	46	.01	.01	.00	0.	*	1	2050	126	.01	.01	.00	2.
1	0740	47	.01	.01	.00	0.	*	1	2100	127	.01	.01	.00	2.
1	0750	48	.01	.01	.00	0.	*	1	2110	128	.00	.00	.00	2.
1	0800	49	.01	.01	.00	0.	*	1	2120	129	.00	.00	.00	2.
1	0810	50	.01	.01	.00	0.	*	1	2130	130	.00	.00	.00	2.
1	0820	51	.01	.01	.00	0.	*	1	2140	131	.00	.00	.00	2.
1	0830	52	.01	.01	.00	0.	*	1	2150	132	.00	.00	.00	2.
1	0840	53	.01	.01	.00	0.	*	1	2200	133	.00	.00	.00	1.
1	0850	54	.01	.01	.00	0.	*	1	2210	134	.00	.00	.00	1.
1	0900	55	.01	.01	.00	0.	*	1	2220	135	.00	.00	.00	1.
1	0910	56	.01	.01	.00	0.	*	1	2230	136	.00	.00	.00	1.
1	0920	57	.01	.01	.00	0.	*	1	2240	137	.00	.00	.00	1.
1	0930	58	.01	.01	.00	0.	*	1	2250	138	.00	.00	.00	1.
1	0940	59	.01	.01	.00	0.	*	1	2300	139	.00	.00	.00	1.
1	0950	60	.01	.01	.00	0.	*	1	2310	140	.00	.00	.00	1.
1	1000	61	.01	.01	.00	0.	*	1	2320	141	.00	.00	.00	1.
1	1010	62	.01	.01	.00	0.	*	1	2330	142	.00	.00	.00	1.
1	1020	63	.01	.01	.00	0.	*	1	2340	143	.00	.00	.00	1.
1	1030	64	.01	.01	.00	0.	*	1	2350	144	.00	.00	.00	1.
1	1040	65	.01	.01	.00	0.	*	2	0000	145	.00	.00	.00	1.
1	1050	66	.01	.01	.00	0.	*	2	0010	146	.00	.00	.00	1.
1	1100	67	.01	.01	.00	0.	*	2	0020	147	.00	.00	.00	1.
1	1110	68	.02	.02	.00	0.	*	2	0030	148	.00	.00	.00	1.
1	1120	69	.02	.02	.00	0.	*	2	0040	149	.00	.00	.00	1.
1	1130	70	.02	.02	.00	0.	*	2	0050	150	.00	.00	.00	1.
1	1140	71	.02	.02	.00	0.	*	2	0100	151	.00	.00	.00	1.
1	1150	72	.02	.02	.00	0.	*	2	0110	152	.00	.00	.00	1.
1	1200	73	.02	.02	.00	0.	*	2	0120	153	.00	.00	.00	1.
1	1210	74	.04	.04	.00	0.	*	2	0130	154	.00	.00	.00	1.
1	1220	75	.04	.04	.00	0.	*	2	0140	155	.00	.00	.00	1.
1	1230	76	.04	.04	.00	0.	*	2	0150	156	.00	.00	.00	1.
1	1240	77	.04	.04	.00	0.	*	2	0200	157	.00	.00	.00	0.
1	1250	78	.04	.04	.00	1.	*	2	0210	158	.00	.00	.00	0.
1	1300	79	.04	.03	.00	1.	*	2	0220	159	00	.00	.00	0.
1	1310	80	.02	.02	.00	1.	*	2	0230	160	.00	.00	.00	0.
							*							

TOTAL RAINFALL = 1.50, TOTAL LOSS = 1.33, TOTAL EXCESS = .17

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
			6-HR	24-HR	72-HR	26.50-HR
(CFS)	(HR)	(CFS)				
2.	21.00		2.	1.	1.	1.
		(INCHES)	.085	.164	.164	.164
		(AC-FT)	1.	2.	2.	2.

CUMULATIVE AREA = .18 SQ MI

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD			BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
				6-HOUR	24-HOUR	72-HOUR			
HYDROGRAPH AT	INFLOW	2.	21.00	2.	1.	1.	.18		

*** NORMAL END OF HEC-1 ***

Sht 2g of 7
12/29/97
GRF

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1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*          SEPTEMBER 1990               *
*           VERSION 4.0                 *
*                                       *
* RUN DATE  12/29/1997  TIME  15:05:06  *
*                                       *
*****************************************
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*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*        609 SECOND STREET              *
*      DAVIS, CALIFORNIA 95616          *
*          (916) 756-1104               *
*                                       *
*****************************************
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```
X    X  XXXXXXX   XXXXX          X
X    X  X        X     X       XX
X    X  X        X             X
XXXXXXX  XXXX    X       XXXXX X
X    X  X        X             X
X    X  X        X     X       X
X    X  XXXXXXX   XXXXX        XXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

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          LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10
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            2           ID   CONTRIBUTING AREA ABOVE RR MATLS C2/C3/C4, NO CULVERT UNDER INTERSTATE
            3           ID   10-YR, 24-HR STORM
            4           ID   PRECIP ESTIMATES FROM PRELIMINARY USGS RESULTS, 1995
            5           ID   DIMENSIONLESS UNIT GRAPH FROM USGS (AVG GRAPH); INFILTRATION ESTIMATED
            6           ID   G. FISCHER, MAXIM, 12/29/97
*** FREE ***
            7           IT      10                    160
            8           IN      60
            9           IO       1       0
                        * JR  FLOW     1.0   0.895

           10           KK  INFLOW   INFLOW INTO SEDIMENT BASIN
           11           BA   0.022
           12           BF    0.01    0.01       1
           13           PI    .027    .027    .027    .048    .048    .048    .049    .049    .056    .081
           14           PI    .081    .136    .235    .124    .081    .056    .056    .049    .048    .048
           15           PI    .048    .027    .027    .027
           16           LS       0      75    0.05
           17           UC   0.098     2.0
                        * KK   OUT   OUTFLOW FROM DRY FORK DAM
                        * RS     1    ELEV  2486.0
                        * SQ     0      74     116     228     437     540     642     744
                        * SE2485.0    2487  2489.8  2491.5  2492.9  2493.5  2494.0  2494.4
                        * SV     0     400    1520    3820    7500    8260    9210
                        * SE  2450    2460    2470    2480    2490    2492  2494.5
                        * ST2494.5    1300     2.6     1.5
                        *
                        * **
                        *
           18           ZZ
```

```
1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*          SEPTEMBER 1990               *
*           VERSION 4.0                 *
*                                       *
* RUN DATE  12/29/1997  TIME  15:05:06  *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*        609 SECOND STREET              *
*      DAVIS, CALIFORNIA 95616          *
*          (916) 756-1104               *
*                                       *
*****************************************
```

RUNOFF FROM NON-PRIORITY SOIL AREA EAST OF ROCKER FILE:ROCKER2.HC1
CONTRIBUTING AREA ABOVE RR MATLS C2/C3/C4, NO CULVERT UNDER INTERSTATE
10-YR, 24-HR STORM
PRECIP ESTIMATES FROM PRELIMINARY USGS RESULTS, 1995
DIMENSIONLESS UNIT GRAPH FROM USGS (AVG GRAPH); INFILTRATION ESTIMATED
G. FISCHER, MAXIM, 12/29/97

```
  9 IO          OUTPUT CONTROL VARIABLES
                     IPRNT          1  PRINT CONTROL
                     IPLOT          0  PLOT CONTROL
                     QSCAL          0.  HYDROGRAPH PLOT SCALE

    IT          HYDROGRAPH TIME DATA
                     NMIN          10  MINUTES IN COMPUTATION INTERVAL
                    IDATE      1    0  STARTING DATE
                    ITIME        0000  STARTING TIME
                       NQ         160  NUMBER OF HYDROGRAPH ORDINATES
                    NDDATE     2    0  ENDING DATE
                    NDTIME       0230  ENDING TIME
                    ICENT          19  CENTURY MARK

                  COMPUTATION INTERVAL      .17 HOURS
                      TOTAL TIME BASE   26.50 HOURS

        ENGLISH UNITS
            DRAINAGE AREA         SQUARE MILES
            PRECIPITATION DEPTH   INCHES
            LENGTH, ELEVATION     FEET
            FLOW                  CUBIC FEET PER SECOND
            STORAGE VOLUME        ACRE-FEET
            SURFACE AREA          ACRES
            TEMPERATURE           DEGREES FAHRENHEIT
```

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*** ***

```
          **************
          *            *
10 KK     *   INFLOW   *       INFLOW INTO SEDIMENT BASIN
          *            *
          **************

 8 IN         TIME DATA FOR INPUT TIME SERIES
                   JXMIN          60  TIME INTERVAL IN MINUTES
                  JXDATE       1   0  STARTING DATE
                  JXTIME           0  STARTING TIME

            SUBBASIN RUNOFF DATA

11 BA        SUBBASIN CHARACTERISTICS
                   TAREA         .02  SUBBASIN AREA

12 BF        BASE FLOW CHARACTERISTICS
                  STRTQ          .01  INITIAL FLOW
                  QRCSN          .01  BEGIN BASE FLOW RECESSION
                  RTIOR      1.00000  RECESSION CONSTANT

            PRECIPITATION DATA

11 PB                STORM       1.50  BASIN TOTAL PRECIPITATION

11 PI        INCREMENTAL PRECIPITATION PATTERN
               .00   .00   .00   .00   .00   .00   .00   .00   .00   .00
               .00   .00   .00   .00   .00   .00   .00   .00   .01   .01
               .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
               .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
               .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
               .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
               .01   .01   .01   .01   .01   .01   .02   .02   .02   .02
               .02   .02   .04   .04   .04   .04   .04   .04   .02   .02
               .02   .02   .02   .02   .01   .01   .01   .01   .01   .01
               .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
               .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
               .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
               .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
               .00   .00   .00   .00   .00   .00   .00   .00   .00   .00
               .00   .00   .00   .00

16 LS        SCS LOSS RATE
                  STRTL          .67  INITIAL ABSTRACTION
                 CRVNBR        75.00  CURVE NUMBER
                  RTIMP          .05  PERCENT IMPERVIOUS AREA

17 UC        CLARK UNITGRAPH
                     TC          .10  TIME OF CONCENTRATION
                      R         2.00  STORAGE COEFFICIENT

            SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                  ***

TC INCREASED TO DELTA T OF   .17 HR

                              UNIT HYDROGRAPH PARAMETERS
                        CLARK   TC=    .17 HR,      R=  2.00 HR
                        SNYDER  TP=    .29 HR,     CP=   .15

                              UNIT HYDROGRAPH
                          65 END-OF-PERIOD ORDINATES
          3.    7.    6.    6.    5.    5.    4.    4.    4.    3.
          3.    3.    3.    2.    2.    2.    2.    2.    2.    1.
          1.    1.    1.    1.    1.    1.    1.    1.    1.    1.
          1.    1.    0.    0.    0.    0.    0.    0.    0.    0.
          0.    0.    0.    0.    0.    0.    0.    0.    0.    0.
          0.    0.    0.    0.    0.    0.    0.    0.    0.    0.
          0.    0.    0.    0.    0.
```

****

HYDROGRAPH AT STATION INFLOW

****

DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q		DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
1		0000	1	.00	.00	.00	0.		1		1320	81	.02	.02	.00	0.
1		0010	2	.00	.00	.00	0.		1		1330	82	.02	.02	.00	0.
1		0020	3	.00	.00	.00	0.		1		1340	83	.02	.02	.00	0.
1		0030	4	.00	.00	.00	0.		1		1350	84	.02	.02	.00	0.
1		0040	5	.00	.00	.00	0.		1		1400	85	.02	.02	.00	0.
1		0050	6	.00	.00	.00	0.		1		1410	86	.01	.01	.00	0.
1		0100	7	.00	.00	.00	0.		1		1420	87	.01	.01	.00	0.
1		0110	8	.00	.00	.00	0.		1		1430	88	.01	.01	.00	0.
1		0120	9	.00	.00	.00	0.		1		1440	89	.01	.01	.00	0.
1		0130	10	.00	.00	.00	0.		1		1450	90	.01	.01	.00	0.
1		0140	11	.00	.00	.00	0.		1		1500	91	.01	.01	.00	0.
1		0150	12	.00	.00	.00	0.		1		1510	92	.01	.01	.00	0.
1		0200	13	.00	.00	.00	0.		1		1520	93	.01	.01	.00	0.
1		0210	14	.00	.00	.00	0.		1		1530	94	.01	.01	.00	0.
1		0220	15	.00	.00	.00	0.		1		1540	95	.01	.01	.00	0.
1		0230	16	.00	.00	.00	0.		1		1550	96	.01	.01	.00	0.
1		0240	17	.00	.00	.00	0.		1		1600	97	.01	.01	.00	0.
1		0250	18	.00	.00	.00	0.		1		1610	98	.01	.01	.00	0.
1		0300	19	.00	.00	.00	0.		1		1620	99	.01	.01	.00	0.
1		0310	20	.01	.01	.00	0.		1		1630	100	.01	.01	.00	0.
1		0320	21	.01	.01	.00	0.		1		1640	101	.01	.01	.00	0.
1		0330	22	.01	.01	.00	0.		1		1650	102	.01	.01	.00	0.
1		0340	23	.01	.01	.00	0.		1		1700	103	.01	.01	.00	0.
1		0350	24	.01	.01	.00	0.		1		1710	104	.01	.01	.00	0.
1		0400	25	.01	.01	.00	0.		1		1720	105	.01	.01	.00	0.
1		0410	26	.01	.01	.00	0.		1		1730	106	.01	.01	.00	0.
1		0420	27	.01	.01	.00	0.		1		1740	107	.01	.01	.00	0.
1		0430	28	.01	.01	.00	0.		1		1750	108	.01	.01	.00	0.
1		0440	29	.01	.01	.00	0.		1		1800	109	.01	.01	.00	0.
1		0450	30	.01	.01	.00	0.		1		1810	110	.01	.01	.00	0.
1		0500	31	.01	.01	.00	0.		1		1820	111	.01	.01	.00	0.
1		0510	32	.01	.01	.00	0.		1		1830	112	.01	.01	.00	0.
1		0520	33	.01	.01	.00	0.		1		1840	113	.01	.01	.00	0.
1		0530	34	.01	.01	.00	0.		1		1850	114	.01	.01	.00	0.
1		0540	35	.01	.01	.00	0.		1		1900	115	.01	.01	.00	0.

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1	0550	36	.01	.01	.00	0.	*	1	1910	116	.01	.01	.00	0.
1	0600	37	.01	.01	.00	0.	*	1	1920	117	.01	.01	.00	0.
1	0610	38	.01	.01	.00	0.	*	1	1930	118	.01	.01	.00	0.
1	0620	39	.01	.01	.00	0.	*	1	1940	119	.01	.01	.00	0.
1	0630	40	.01	.01	.00	0.	*	1	1950	120	.01	.01	.00	0.
1	0640	41	.01	.01	.00	0.	*	1	2000	121	.01	.01	.00	0.
1	0650	42	.01	.01	.00	0.	*	1	2010	122	.01	.01	.00	0.
1	0700	43	.01	.01	.00	0.	*	1	2020	123	.01	.01	.00	0.
1	0710	44	.01	.01	.00	0.	*	1	2030	124	.01	.01	.00	0.
1	0720	45	.01	.01	.00	0.	*	1	2040	125	.01	.01	.00	0.
1	0730	46	.01	.01	.00	0.	*	1	2050	126	.01	.01	.00	0.
1	0740	47	.01	.01	.00	0.	*	1	2100	127	.01	.01	.00	0.
1	0750	48	.01	.01	.00	0.	*	1	2110	128	.00	.00	.00	0.
1	0800	49	.01	.01	.00	0.	*	1	2120	129	.00	.00	.00	0.
1	0810	50	.01	.01	.00	0.	*	1	2130	130	.00	.00	.00	0.
1	0820	51	.01	.01	.00	0.	*	1	2140	131	.00	.00	.00	0.
1	0830	52	.01	.01	.00	0.	*	1	2150	132	.00	.00	.00	0.
1	0840	53	.01	.01	.00	0.	*	1	2200	133	.00	.00	.00	0.
1	0850	54	.01	.01	.00	0.	*	1	2210	134	.00	.00	.00	0.
1	0900	55	.01	.01	.00	0.	*	1	2220	135	.00	.00	.00	0.
1	0910	56	.01	.01	.00	0.	*	1	2230	136	.00	.00	.00	0.
1	0920	57	.01	.01	.00	0.	*	1	2240	137	.00	.00	.00	0.
1	0930	58	.01	.01	.00	0.	*	1	2250	138	.00	.00	.00	0.
1	0940	59	.01	.01	.00	0.	*	1	2300	139	.00	.00	.00	0.
1	0950	60	.01	.01	.00	0.	*	1	2310	140	.00	.00	.00	0.
1	1000	61	.01	.01	.00	0.	*	1	2320	141	.00	.00	.00	0.
1	1010	62	.01	.01	.00	0.	*	1	2330	142	.00	.00	.00	0.
1	1020	63	.01	.01	.00	0.	*	1	2340	143	.00	.00	.00	0.
1	1030	64	.01	.01	.00	0.	*	1	2350	144	.00	.00	.00	0.
1	1040	65	.01	.01	.00	0.	*	2	0000	145	.00	.00	.00	0.
1	1050	66	.01	.01	.00	0.	*	2	0010	146	.00	.00	.00	0.
1	1100	67	.01	.01	.00	0.	*	2	0020	147	.00	.00	.00	0.
1	1110	68	.02	.02	.00	0.	*	2	0030	148	.00	.00	.00	0.
1	1120	69	.02	.02	.00	0.	*	2	0040	149	.00	.00	.00	0.
1	1130	70	.02	.02	.00	0.	*	2	0050	150	.00	.00	.00	0.
1	1140	71	.02	.02	.00	0.	*	2	0100	151	.00	.00	.00	0.
1	1150	72	.02	.02	.00	0.	*	2	0110	152	.00	.00	.00	0.
1	1200	73	.02	.02	.00	0.	*	2	0120	153	.00	.00	.00	0.
1	1210	74	.04	.04	.00	0.	*	2	0130	154	.00	.00	.00	0.
1	1220	75	.04	.04	.00	0.	*	2	0140	155	.00	.00	.00	0.
1	1230	76	.04	.04	.00	0.	*	2	0150	156	.00	.00	.00	0.
1	1240	77	.04	.04	.00	0.	*	2	0200	157	.00	.00	.00	0.
1	1250	78	.04	.04	.00	0.	*	2	0210	158	.00	.00	.00	0.
1	1300	79	.04	.03	.00	0.	*	2	0220	159	.00	.00	.00	0.
1	1310	80	.02	.02	.00	0.	*	2	0230	160	.00	.00	.00	0.
							*							

TOTAL RAINFALL = 1.50, TOTAL LOSS = 1.33, TOTAL EXCESS = .17

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	26.50-HR
		(CFS)	0.	0.	0.	0.
0.	21.00	(INCHES)	.089	.179	.181	.181
		(AC-FT)	0.	0.	0.	0.

CUMULATIVE AREA = .02 SQ MI

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	INFLOW	0.	21.00	0.	0.	0.	.02		

*** NORMAL END OF HEC-1 ***

MAXIM TECHNOLOGIES INC

BY GRF DATE 12/29/97

JOB TITLE SST - RR Matls JOB NUMBER

SUBJECT Non priority soils runoff SHEET 3 OF 7

OTHER METHODS OF SIZING SEDIMENT BASINS

SURFACE LOAD THEORY

REF: STORM-WATER DETENTION, STAHRE - URBANDS, 1990

Particle size distribution:

See attached laboratory gradations for waste materials on the embankments in the operable unit. It is estimated that similar particle distributions exist on the non-priority embankment.

Target particle size = 200 mesh = 0.005 in

= 0.127 mm = 127 μm

Try to achieve 80% sedimentation effect.

From Fig 23.3 (ref), max allowable surface loading is ~ 21 m^3/hr per m^2 (m/hr)

$21\ m/hr \times 3.28\ \frac{ft}{m} \times \frac{1\ hr}{3600\ sec} = 0.019\ ft/sec$

$= 0.019\ ft^3/sec$ per ft^2

If Q peak = 2 cfs (for 0.18 sm drainage area),

$A_{min} = \frac{2}{.019} = 104\ ft^2$

↳ seems to be small

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BY GRF DATE 1/2/98

JOB TITLE SST- RR Mat'ls JOB NUMBER

SUBJECT Non-priority soils runoff SHEET 4 of 7

Try sedimentation effect of 100%:

for 127 μm particle, the maximum surface loading Q/A = 9 m/hr

= 0.0082 ft/sec

$A_{min} = \frac{2\ cfs}{.0082\ ft/sec} = 244\ ft^2$ — still small.

Estimate pond size if the target particle size was 1/4 of the 200 mesh ($\frac{127\ \mu m}{4} = 32\ \mu m$).

For 100% effectiveness:

$Q/A \cong 0.6$ m/hr = 0.0006 ft/sec

$A_{min} = \frac{2\ cfs}{.0006\ ft/sec} = 3250\ ft^2$ or ~ 60 ft square

This compares to ~ 150 ft square using the previous method.

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BY CRF DATE 1/5/98

JOB TITLE SST - RR mat'ls JOB NUMBER

SUBJECT Non-priority soils runoff SHEET 5 OF 7

Smaller Basin Determination

Use the Rational Method to determine peak flows (Ref: Residential Storm Water Management, ULI, ASCE, NAHB, 1975)

$Q = CIA$

$C = 0.3$

$A = \frac{5ac \times 1100}{43560} = 14$ acres

I = intensity (see below)

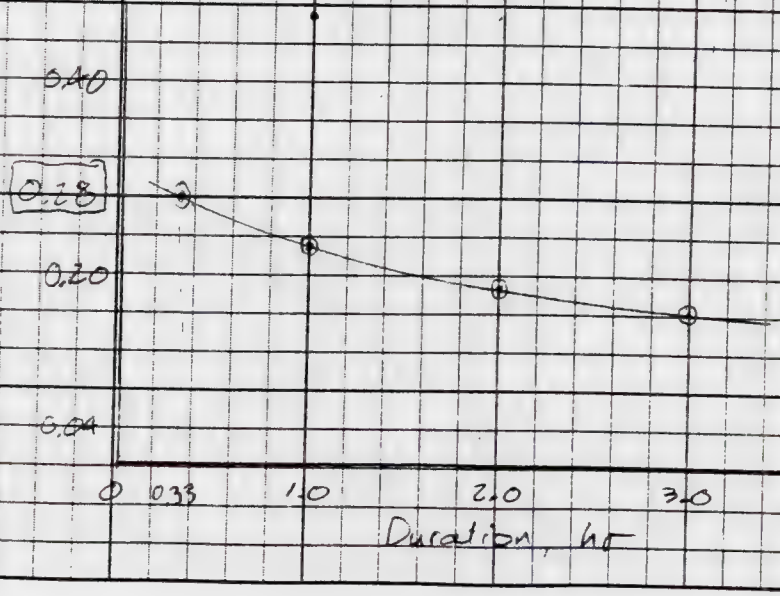
Travel Time = overland flow + channel flow

Overland flow (from Fig 2, ref) = 18 mins

Channel flow = 500 ft / 5 fps = 100 secs = 2 mins

Total Travel Time = 20 minutes

From hyetograph max intensity = 0.235 in/hr (for 1 hr)



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BY GRF DATE 1/5/98

JOB TITLE SST - RR mat'ls JOB NUMBER

SUBJECT Non-priority soils runoff SHEET 6 of 7

$\therefore$ $I = 0.28$ in/hr

$Q = 0.3(0.28)(14) = 1.2$ cfs

for $Q/A_{max} = 0.0006$ ft/sec

$A_{min} = \frac{1.2}{.0006} = 2000\ ft^2$ or ~ 45 ft square

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GRF

Table 1

RUNOFF COEFFICIENTS

Description of Area	Runoff Coefficients
Business	
Downtown	0.70 to 0.95
Neighborhood	0.50 to 0.70
Residential	
Single Family	0.30 to 0.50
Multi-units, detached	0.40 to 0.60
Multi-units, attached	0.60 to 0.75
Residential (suburban)	0.25 to 0.40
Apartment	0.50 to 0.70
Industrial	
Light	0.50 to 0.80
Heavy	0.60 to 0.90
Parks, cemeteries	0.10 to 0.25
Railroad yard	0.20 to 0.35
Unimproved	0.10 to 0.30

Character of Surface	Runoff Coefficients
Pavement	
Asphalt or Concrete	0.70 to 0.95
Brick	0.70 to 0.85
Roofs	0.70 to 0.95
Lawns, sandy soil	
Flat, 2 percent	0.05 to 0.10
Average, 2 to 7 percent	0.10 to 0.15
Steep, 7 percent or more	0.15 to 0.20
Lawns, heavy soil	
Flat, 2 percent	0.13 to 0.17
Average, 2 to 7 percent	0.18 to 0.22
Steep, 7 percent or more	0.25 to 0.35

The coefficients in these two tabulations are only applicable for storms of five to ten year return frequencies, and were originally developed when many streets were uncurbed and drainage was conveyed in roadside swales.

For recurrence intervals longer than ten years, the indicated runoff coefficients should be increased assuming that nearly all of the rainfall in excess of that expected from the ten year recurrence interval rainfall will become runoff and should be accommodated by an increased runoff coefficient.

The runoff coefficients indicated for different soil conditions reflect runoff behavior shortly after initial construction. With the passage of time, the runoff behavior of sandy soil areas will tend to approach that of heavy soil areas. If the designer's interest is long-term, the reduced response indicated for sandy soil areas should be disregarded.

Source: *Design and Construction of Sanitary and Storm Sewers*, ASCE Manual of Practice No. 37, 1970. Notes revised by D. Earl Jones, Jr.

Sht 6b of 1
1/5/98
GRF

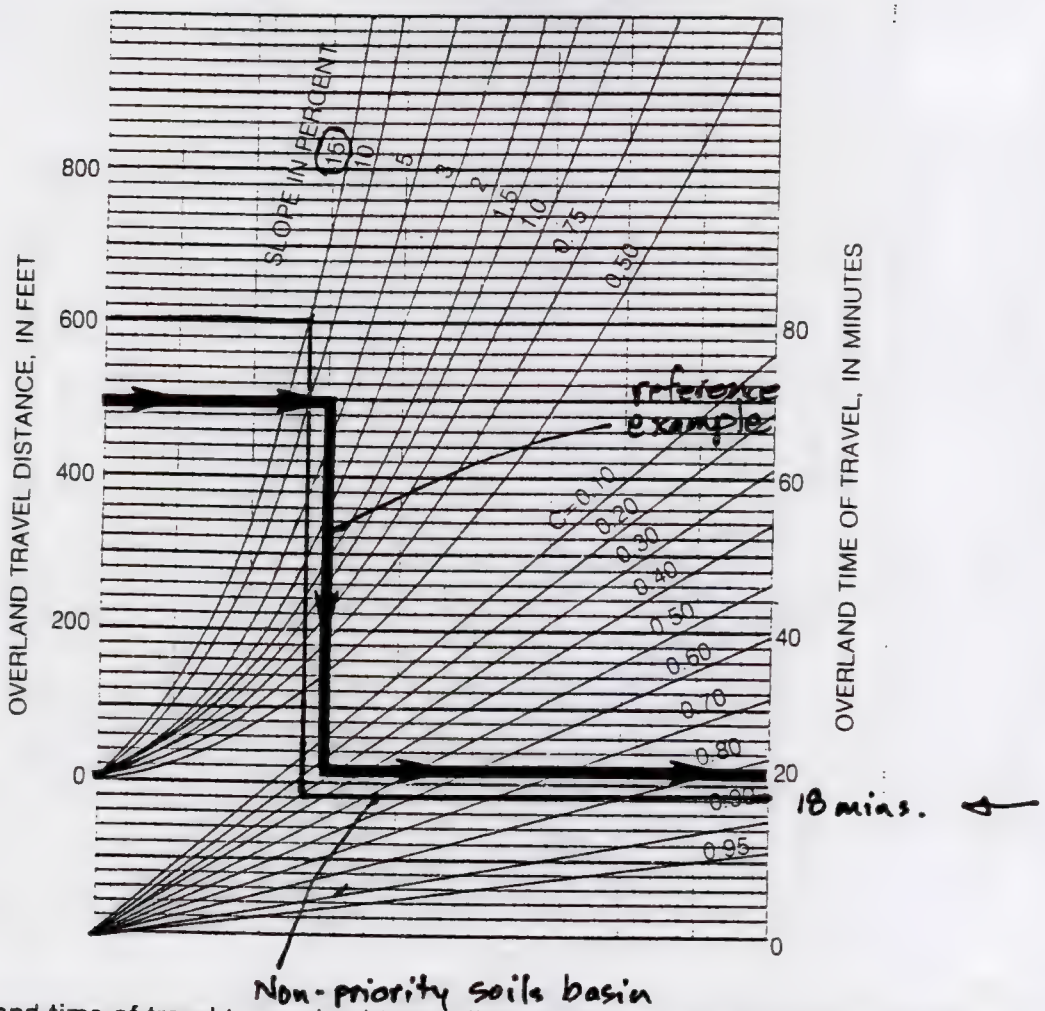

Figure 2
Relation of overland time of travel to overland travel distance, average overland slope, and coefficient C —for use in Rational Method.

Source:
Wright-McLaughlin Engineers/
"Airport Drainage,"
Federal Aviation Administration
Washington, DC 1965.

MAXIM TECHNOLOGIES INC

BY GRF DATE 1/5/98

JOB TITLE SST - RR mat'ls JOB NUMBER

SUBJECT Non-priority soils SHEET 7 of 7

MDEQ Method

Ref: Montana Sediment and Erosion Control Manual, MDEQ, 1996

$SA = 1.2\, Q_{10} / V_{bod}$

$Q_{10} = 1.2$ cfs or 2 cfs

$V_{bod} =$ 0.00096 ft/sec for 0.02 mm particle (20 um)

larger basin → $SA = \frac{1.2\,(2)}{.00096} = 2500\ ft^2$ or ~ 50 ft sq.

smaller basin → $SA = \frac{1.2\,(1.2)}{.00096} = 1500\ ft^2$ or ~ 40 ft sq

∴ USE MDEQ stds for sizing sediment basins. Results are close to surface - load theory results.

MAXIM TECHNOLOGIES INC

BY G. FISCHER DATE 1/16/98

JOB TITLE SST - RR Materials JOB NUMBER 973170I-190

SUBJECT Non-Priority Soils Sediment Basins SHEET 1 of 5

DETAILED DESIGN OF SEDIMENT BASINS

DRAINAGE AREAS

	BASIN	1ST READING	2ND READING	AREA SQ IN	(1"=100' map) AREA (ACRES)	(1"=2000' map) AREA (SQ MI)
S-7	C15	0	3818	38.18	8.8	—
S-6	C14	526	4766	42.40	9.7	—
S-5	C11-C13	6321	6451	1.3	—	0.19
S-4	C7-C10	4578	10835	62.57	14.4	—
S-3	C5.5	450	2866	24.16	5.5	—
-2	C5-C6	434	7520	70.86	16.3	—
S-2	C2-C4/C1					
	a	1574	3725	21.51	4.9	—
	b	5776	10603	48.27	11.1	—
	c	1434	6741	53.07	12.2	—
	d	5182	8213	30.31	7.0	—
	Total				35.2	—
S-1	Whiskey Gulch	9245	9848	6.03	—	0.87

MAXIM TECHNOLOGIES INC

BY G. FISCHER DATE 1/16/98

JOB TITLE SST - RR Materials JOB NUMBER

SUBJECT Sed Basins SHEET 2 of 5

PEAK FLOW ESTIMATES

Smaller Basins will use the Rational Method

	BASIN	Overland Flow Travel Time (min)	Channel Flow Travel Time (min)	Total Travel Time (min)	Rainfall Intensity I * (in/hr)
S-7	C15	22 (90' @ 11%)	1 (550', 5 fps)	23	0.27
S-6	C14	15 (+1.4 ac?)	2 (700', 5 fps)	17	0.29
S-4	C7-C10	18 (550' @ 13%)	3 (1200', 5 fps)	21	0.28
S-3	C5.5	16 (5.5 ac)	2 (500', 5 fps)	18	0.29
S-2	C5-C6	18 (5.0 ac)	2 (600', 5 fps)	20	0.28
S-2	C2-C4/C1	24 (500' @ 13%)	4 (1100', 4 fps)	28	0.26

* For a 10-yr, 24-hr storm - see sht 5 of G. Fischer calcs, 1/6/98

$Q_{C15} = 0.3 (8.8)(0.27) = \underline{0.71 \text{ cfs}}$

$Q_{C14} = 0.3 (9.7)(0.29) = \underline{0.84 \text{ cfs}}$

$Q_{C7-C10} = 0.3 (14.4)(0.28) = \underline{1.21 \text{ cfs}}$

$Q_{C5.5} = 0.3 (5.5)(0.29) = \underline{0.48 \text{ cfs}}$

$Q_{C5-C6} = 0.3 (16.3)(0.28) = \underline{1.37 \text{ cfs}}$

$Q_{C2-C4/C1} = 0.3 (35.2)(0.26) = \underline{2.75 \text{ cfs}}$

Peak = $.48 + \frac{1.37}{2} = 1.17$ cfs (see sht 4)

combined because of MWRR-2. See sht 4.

GRF 1/16/98
Maxim 3 OF 5

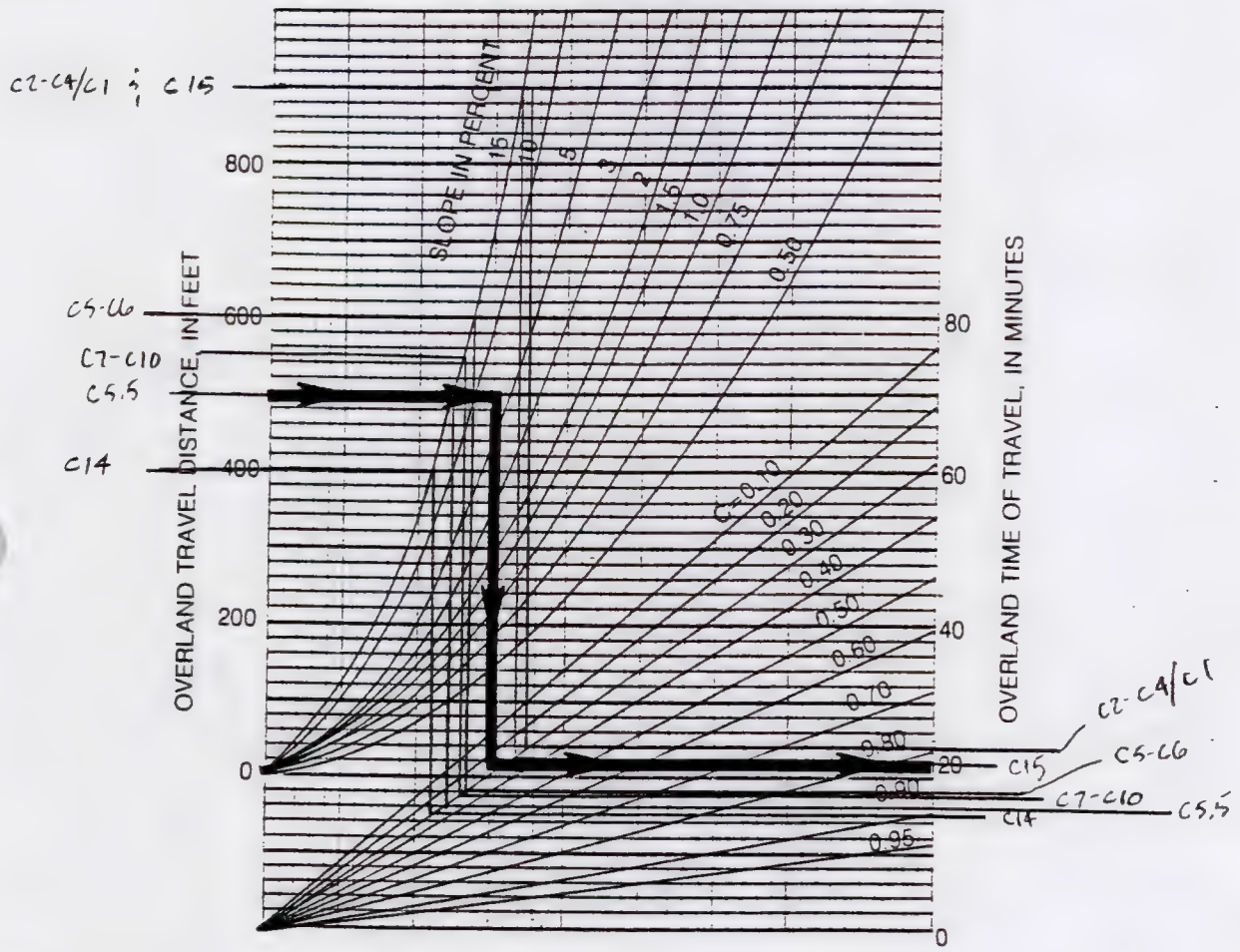

Figure 2
Relation of overland time of travel to overland travel distance, average overland slope, and coefficient C —for use in Rational Method.

Source:
Wright-McLaughlin Engineers/
"Airport Drainage,"
Federal Aviation Administration
Washington, DC 1965.

MAXIM TECHNOLOGIES INC

BY GRF DATE 1/19/98

JOB TITLE SST - RR Mat'ls JOB NUMBER

SUBJECT Sed basins SHEET 4 of 5

TO MEET MDEQ Stds, (Ref: Montana Sediment and Erosion Control Manual, MDEQ, 1996)

Required surface area is

$$SA = \frac{1.2\, Q_{10}}{V_{bad}}$$

V_{bad} = 0.00096 fps for a 20um particle

S-7 $SA_{C1-5} = \frac{1.2(0.71)}{.00096} = 890$ sf

S-6 $SA_{C1-4} = \frac{1.2(0.84)}{.00096} = 1050$ sf

S-4 $SA_{C7-C10} = \frac{1.2(1.21)}{.00096} = 1510$ sf

S-3 $SA_{C5-5} = \frac{1.2(0.48)}{0.00096} = 600$ sf → SA_{C5-5} will be 600 + 850 = 1450 sf

S-2 $SA_{C5-C6} = \frac{1.2(1.37)}{.00096} = 1710$ sf → These 2 areas will be combined as a result of C5-C6 being in the location of MWRR-2. The sediment basin for both areas will be in the drainage below C1/C2-C4.

S-2 $SA_{C2-C4/C1} = \frac{1.2(2.75)}{.00096} = 3440$ sf.

With MWRR-2, half of SA_{C5-C6} will go to SA_{C5-5}. Total area at SA_{C5-5} will be 600 + 850 = 1450 sf

Combined surface area is

1710 + 3440 = 5150 sf

MAXIM TECHNOLOGIES INC

BY GRF DATE 1/20/98

JOB TITLE SST - RR Mat'ls JOB NUMBER

SUBJECT Sed Basins SHEET 5 of 5

For larger drainage areas, HEC-1 was used to estimate peak flow.

for C11-C13, DA = 0.18 SM

FROM HEC-1 File ROCKER1.HC1 (see 1/5/98 calcs by Fischer)

Qpeak = 2 cfs, which is a rounded value

Since combined C5-C6 + C1/C2-C4 has a larger DA, has 4.12 cfs and C11-C13 has use

Qpeak = 6 cfs for C11-C13 (S-5)

For Whiskey Gulch, HEC-1 File WHISKEY1.HC1,

Qpeak = 8 cfs.

S-5 $SA_{C11-C13} = \frac{1.2(6)}{.00096} = 7500\ ft^2$

S-1 $SA_{WHISKEY} = \frac{1.2(8)}{.00096} = 10{,}000\ ft^2$

5a of 5
1/20/98
GRT

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1*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*          SEPTEMBER 1990               *
*           VERSION 4.0                 *
*                                       *
*  RUN DATE  01/20/1998  TIME  11:40:25 *
*                                       *
*****************************************
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*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*        609 SECOND STREET              *
*      DAVIS, CALIFORNIA 95616          *
*          (916) 756-1104               *
*                                       *
*****************************************
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X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X        XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX          XXX
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THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

1 HEC-1 INPUT PAGE 1

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          LINE          ID.....1.......2.......3.......4.......5.......6.......7.......8.......9......10

            1           ID   RUNOFF FROM NON-PRIORITY SOIL AREA EAST OF ROCKER     FILE:WHISKEY1.HC1
            2           ID   CONTRIBUTING AREA FROM WHISKEY GULCH, CULVERT UNDER INTERSTATE
            3           ID   10-YR, 24-HR STORM
            4           ID   PRECIP ESTIMATES FROM PRELIMINARY USGS RESULTS, 1995
            5           ID   DIMENSIONLESS UNIT GRAPH FROM USGS (AVG GRAPH); INFILTRATION ESTIMATED
            6           ID   G. FISCHER, MAXIM, 12/29/97
*** FREE ***
            7           IT     10                    300
            8           IN     60
            9           IO      1       0
                        * JR  FLOW     1.0    0.895

           10           KK  INFLOW    INFLOW INTO SEDIMENT BASIN
           11           BA    0.87
           12           BF    0.01    0.01      1
           13           PI    .027    .027    .027    .048    .048    .048    .049    .049    .056    .081
           14           PI    .081    .136    .235    .124    .081    .056    .056    .049    .048    .048
           15           PI    .048    .027    .027    .027
           16           LS       0      75    0.05
           17           UC   0.098     2.0
                        * KK   OUT   OUTFLOW FROM DRY FORK DAM
                        * RS     1    ELEV  2484.0
                        * SQ     0      74     116     228     437     540     642     744
                        * SE2485.0    2487  2489.8  2491.5  2492.9  2493.5  2494.0  2494.4
                        * SV     0     400    1520    3820    7500    8260    9210
                        * SE  2450    2460    2470    2480    2490    2492  2494.5
                        * ST2494.5    1300     2.6     1.5
                        *
                        * **
                        *
           18           ZZ
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1

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*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*          SEPTEMBER 1990               *
*           VERSION 4.0                 *
*                                       *
*  RUN DATE  01/20/1998  TIME  11:40:25 *
*                                       *
*****************************************
```

```
*****************************************
*                                       *
*   U.S. ARMY CORPS OF ENGINEERS        *
*   HYDROLOGIC ENGINEERING CENTER       *
*        609 SECOND STREET              *
*      DAVIS, CALIFORNIA 95616          *
*          (916) 756-1104               *
*                                       *
*****************************************
```

RUNOFF FROM NON-PRIORITY SOIL AREA EAST OF ROCKER FILE:WHISKEY1.HC1
CONTRIBUTING AREA FROM WHISKEY GULCH, CULVERT UNDER INTERSTATE
10-YR, 24-HR STORM
PRECIP ESTIMATES FROM PRELIMINARY USGS RESULTS, 1995
DIMENSIONLESS UNIT GRAPH FROM USGS (AVG GRAPH); INFILTRATION ESTIMATED
G. FISCHER, MAXIM, 12/29/97

9 IO OUTPUT CONTROL VARIABLES

IPRNT	1	PRINT CONTROL
IPLOT	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA

NMIN	10	MINUTES IN COMPUTATION INTERVAL
IDATE	1 0	STARTING DATE
ITIME	0000	STARTING TIME
NQ	300	NUMBER OF HYDROGRAPH ORDINATES
NDDATE	3 0	ENDING DATE
NDTIME	0150	ENDING TIME
ICENT	19	CENTURY MARK

COMPUTATION INTERVAL .17 HOURS
TOTAL TIME BASE 49.83 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

*** ***

```
          **************
          *            *
10 KK     *   INFLOW   *       INFLOW INTO SEDIMENT BASIN
          *            *
          **************

 8 IN         TIME DATA FOR INPUT TIME SERIES
                   JXMIN          60  TIME INTERVAL IN MINUTES
                  JXDATE       1   0  STARTING DATE
                  JXTIME           0  STARTING TIME

              SUBBASIN RUNOFF DATA

11 BA         SUBBASIN CHARACTERISTICS
                   TAREA         .87  SUBBASIN AREA

12 BF         BASE FLOW CHARACTERISTICS
                   STRTQ         .01  INITIAL FLOW
                   QRCSN         .01  BEGIN BASE FLOW RECESSION
                   RTIOR     1.00000  RECESSION CONSTANT

              PRECIPITATION DATA

11 PB              STORM        1.50  BASIN TOTAL PRECIPITATION

11 PI           INCREMENTAL PRECIPITATION PATTERN
                  .00   .00   .00   .00   .00   .00   .00   .00   .00   .00
                  .00   .00   .00   .00   .00   .00   .00   .00   .01   .01
                  .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
                  .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
                  .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
                  .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
                  .01   .01   .01   .01   .01   .01   .02   .02   .02   .02
                  .02   .02   .04   .04   .04   .04   .04   .04   .02   .02
                  .02   .02   .02   .02   .01   .01   .01   .01   .01   .01
                  .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
                  .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
                  .01   .01   .01   .01   .01   .01   .01   .01   .01   .01
                  .01   .01   .01   .01   .01   .01   .00   .00   .00   .00
                  .00   .00   .00   .00   .00   .00   .00   .00   .00   .00
                  .00   .00   .00   .00

16 LS         SCS LOSS RATE
                   STRTL         .67  INITIAL ABSTRACTION
                  CRVNBR       75.00  CURVE NUMBER
                   RTIMP         .05  PERCENT IMPERVIOUS AREA

17 UC         CLARK UNITGRAPH
                      TC         .10  TIME OF CONCENTRATION
                       R        2.00  STORAGE COEFFICIENT

              SYNTHETIC ACCUMULATED-AREA VS. TIME CURVE WILL BE USED

                                   ***

TC INCREASED TO DELTA T OF   .17 HR

                                UNIT HYDROGRAPH PARAMETERS
                          CLARK   TC=   .17 HR,      R=  2.00 HR
                          SNYDER  TP=   .29 HR,      CP=   .15

                                   UNIT HYDROGRAPH
                              65 END-OF-PERIOD ORDINATES
      135.   259.   238.   219.   201.   185.   171.   157.   144.   133.
      122.   112.   103.    95.    88.    81.    74.    68.    63.    58.
       53.    49.    45.    41.    38.    35.    32.    30.    27.    25.
       23.    21.    20.    18.    17.    15.    14.    13.    12.    11.
       10.     9.     8.     8.     7.     7.     6.     6.     5.     5.
        4.     4.     4.     3.     3.     3.     3.     2.     2.     2.
        2.     2.     2.     1.     1.
```

****

HYDROGRAPH AT STATION INFLOW

****

DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q	DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
1		0000	1	.00	.00	.00	0.	2		0100	151	.00	.00	.00	4.
1		0010	2	.00	.00	.00	0.	2		0110	152	.00	.00	.00	3.
1		0020	3	.00	.00	.00	0.	2		0120	153	.00	.00	.00	3.
1		0030	4	.00	.00	.00	0.	2		0130	154	.00	.00	.00	3.
1		0040	5	.00	.00	.00	0.	2		0140	155	.00	.00	.00	3.
1		0050	6	.00	.00	.00	0.	2		0150	156	.00	.00	.00	2.
1		0100	7	.00	.00	.00	0.	2		0200	157	.00	.00	.00	2.
1		0110	8	.00	.00	.00	0.	2		0210	158	.00	.00	.00	2.
1		0120	9	.00	.00	.00	0.	2		0220	159	.00	.00	.00	2.
1		0130	10	.00	.00	.00	0.	2		0230	160	.00	.00	.00	2.
1		0140	11	.00	.00	.00	0.	2		0240	161	.00	.00	.00	2.
1		0150	12	.00	.00	.00	0.	2		0250	162	.00	.00	.00	1.
1		0200	13	.00	.00	.00	0.	2		0300	163	.00	.00	.00	1.
1		0210	14	.00	.00	.00	0.	2		0310	164	.00	.00	.00	1.
1		0220	15	.00	.00	.00	0.	2		0320	165	.00	.00	.00	1.
1		0230	16	.00	.00	.00	0.	2		0330	166	.00	.00	.00	1.
1		0240	17	.00	.00	.00	0.	2		0340	167	.00	.00	.00	1.
1		0250	18	.00	.00	.00	0.	2		0350	168	.00	.00	.00	1.
1		0300	19	.00	.00	.00	0.	2		0400	169	.00	.00	.00	1.
1		0310	20	.01	.01	.00	0.	2		0410	170	.00	.00	.00	1.
1		0320	21	.01	.01	.00	0.	2		0420	171	.00	.00	.00	1.
1		0330	22	.01	.01	.00	0.	2		0430	172	.00	.00	.00	1.
1		0340	23	.01	.01	.00	0.	2		0440	173	.00	.00	.00	1.
1		0350	24	.01	.01	.00	0.	2		0450	174	.00	.00	.00	1.
1		0400	25	.01	.01	.00	0.	2		0500	175	.00	.00	.00	0.
1		0410	26	.01	.01	.00	0.	2		0510	176	.00	.00	.00	0.
1		0420	27	.01	.01	.00	0.	2		0520	177	.00	.00	.00	0.
1		0430	28	.01	.01	.00	0.	2		0530	178	.00	.00	.00	0.
1		0440	29	.01	.01	.00	0.	2		0540	179	.00	.00	.00	0.
1		0450	30	.01	.01	.00	0.	2		0550	180	.00	.00	.00	0.
1		0500	31	.01	.01	.00	0.	2		0600	181	.00	.00	.00	0.
1		0510	32	.01	.01	.00	0.	2		0610	182	.00	.00	.00	0.
1		0520	33	.01	.01	.00	0.	2		0620	183	.00	.00	.00	0.
1		0530	34	.01	.01	.00	0.	2		0630	184	.00	.00	.00	0.
1		0540	35	.01	.01	.00	0.	2		0640	185	.00	.00	.00	0.

5 of 5
1/20/98
GRF

1	0550	36	.01	.01	.00	0.	*	2	0650	186	.00	.00	.00	0.
1	0600	37	.01	.01	.00	0.	*	2	0700	187	.00	.00	.00	0.
1	0610	38	.01	.01	.00	0.	*	2	0710	188	.00	.00	.00	0.
1	0620	39	.01	.01	.00	0.	*	2	0720	189	.00	.00	.00	0.
1	0630	40	.01	.01	.00	0.	*	2	0730	190	.00	.00	.00	0.
1	0640	41	.01	.01	.00	0.	*	2	0740	191	.00	.00	.00	0.
1	0650	42	.01	.01	.00	0.	*	2	0750	192	.00	.00	.00	0.
1	0700	43	.01	.01	.00	0.	*	2	0800	193	.00	.00	.00	0.
1	0710	44	.01	.01	.00	0.	*	2	0810	194	.00	.00	.00	0.
1	0720	45	.01	.01	.00	0.	*	2	0820	195	.00	.00	.00	0.
1	0730	46	.01	.01	.00	0.	*	2	0830	196	.00	.00	.00	0.
1	0740	47	.01	.01	.00	0.	*	2	0840	197	.00	.00	.00	0.
1	0750	48	.01	.01	.00	0.	*	2	0850	198	.00	.00	.00	0.
1	0800	49	.01	.01	.00	0.	*	2	0900	199	.00	.00	.00	0.
1	0810	50	.01	.01	.00	0.	*	2	0910	200	.00	.00	.00	0.
1	0820	51	.01	.01	.00	0.	*	2	0920	201	.00	.00	.00	0.
1	0830	52	.01	.01	.00	0.	*	2	0930	202	.00	.00	.00	0.
1	0840	53	.01	.01	.00	0.	*	2	0940	203	.00	.00	.00	0.
1	0850	54	.01	.01	.00	0.	*	2	0950	204	.00	.00	.00	0.
1	0900	55	.01	.01	.00	0.	*	2	1000	205	.00	.00	.00	0.
1	0910	56	.01	.01	.00	0.	*	2	1010	206	.00	.00	.00	0.
1	0920	57	.01	.01	.00	0.	*	2	1020	207	.00	.00	.00	0.
1	0930	58	.01	.01	.00	0.	*	2	1030	208	.00	.00	.00	0.
1	0940	59	.01	.01	.00	0.	*	2	1040	209	.00	.00	.00	0.
1	0950	60	.01	.01	.00	0.	*	2	1050	210	.00	.00	.00	0.
1	1000	61	.01	.01	.00	0.	*	2	1100	211	.00	.00	.00	0.
1	1010	62	.01	.01	.00	0.	*	2	1110	212	.00	.00	.00	0.
1	1020	63	.01	.01	.00	0.	*	2	1120	213	.00	.00	.00	0.
1	1030	64	.01	.01	.00	0.	*	2	1130	214	.00	.00	.00	0.
1	1040	65	.01	.01	.00	0.	*	2	1140	215	.00	.00	.00	0.
1	1050	66	.01	.01	.00	0.	*	2	1150	216	.00	.00	.00	0.
1	1100	67	.01	.01	.00	0.	*	2	1200	217	.00	.00	.00	0.
1	1110	68	.02	.02	.00	0.	*	2	1210	218	.00	.00	.00	0.
1	1120	69	.02	.02	.00	0.	*	2	1220	219	.00	.00	.00	0.
1	1130	70	.02	.02	.00	0.	*	2	1230	220	.00	.00	.00	0.
1	1140	71	.02	.02	.00	0.	*	2	1240	221	.00	.00	.00	0.
1	1150	72	.02	.02	.00	0.	*	2	1250	222	.00	.00	.00	0.
1	1200	73	.02	.02	.00	0.	*	2	1300	223	.00	.00	.00	0.
1	1210	74	.04	.04	.00	0.	*	2	1310	224	.00	.00	.00	0.
1	1220	75	.04	.04	.00	0.	*	2	1320	225	.00	.00	.00	0.
1	1230	76	.04	.04	.00	1.	*	2	1330	226	.00	.00	.00	0.
1	1240	77	.04	.04	.00	2.	*	2	1340	227	.00	.00	.00	0.
1	1250	78	.04	.04	.00	2.	*	2	1350	228	.00	.00	.00	0.
1	1300	79	.04	.03	.00	3.	*	2	1400	229	.00	.00	.00	0.
1	1310	80	.02	.02	.00	4.	*	2	1410	230	.00	.00	.00	0.
1	1320	81	.02	.02	.00	5.	*	2	1420	231	.00	.00	.00	0.
1	1330	82	.02	.02	.00	5.	*	2	1430	232	.00	.00	.00	0.
1	1340	83	.02	.02	.00	6.	*	2	1440	233	.00	.00	.00	0.
1	1350	84	.02	.02	.00	6.	*	2	1450	234	.00	.00	.00	0.
1	1400	85	.02	.02	.00	7.	*	2	1500	235	.00	.00	.00	0.
1	1410	86	.01	.01	.00	7.	*	2	1510	236	.00	.00	.00	0.
1	1420	87	.01	.01	.00	7.	*	2	1520	237	.00	.00	.00	0.
1	1430	88	.01	.01	.00	7.	*	2	1530	238	.00	.00	.00	0.
1	1440	89	.01	.01	.00	8.	*	2	1540	239	.00	.00	.00	0.
1	1450	90	.01	.01	.00	8.	*	2	1550	240	.00	.00	.00	0.
1	1500	91	.01	.01	.00	8.	*	2	1600	241	.00	.00	.00	0.
1	1510	92	.01	.01	.00	8.	*	2	1610	242	.00	.00	.00	0.
1	1520	93	.01	.01	.00	8.	*	2	1620	243	.00	.00	.00	0.
1	1530	94	.01	.01	.00	8.	*	2	1630	244	.00	.00	.00	0.
1	1540	95	.01	.01	.00	8.	*	2	1640	245	.00	.00	.00	0.
1	1550	96	.01	.01	.00	8.	*	2	1650	246	.00	.00	.00	0.
1	1600	97	.01	.01	.00	8.	*	2	1700	247	.00	.00	.00	0.
1	1610	98	.01	.01	.00	8.	*	2	1710	248	.00	.00	.00	0.
1	1620	99	.01	.01	.00	8.	*	2	1720	249	.00	.00	.00	0.
1	1630	100	.01	.01	.00	8.	*	2	1730	250	.00	.00	.00	0.
1	1640	101	.01	.01	.00	8.	*	2	1740	251	.00	.00	.00	0.
1	1650	102	.01	.01	.00	8.	*	2	1750	252	.00	.00	.00	0.
1	1700	103	.01	.01	.00	8.	*	2	1800	253	.00	.00	.00	0.
1	1710	104	.01	.01	.00	8.	*	2	1810	254	.00	.00	.00	0.
1	1720	105	.01	.01	.00	8.	*	2	1820	255	.00	.00	.00	0.
1	1730	106	.01	.01	.00	8.	*	2	1830	256	.00	.00	.00	0.
1	1740	107	.01	.01	.00	8.	*	2	1840	257	.00	.00	.00	0.
1	1750	108	.01	.01	.00	8.	*	2	1850	258	.00	.00	.00	0.
1	1800	109	.01	.01	.00	8.	*	2	1900	259	.00	.00	.00	0.
1	1810	110	.01	.01	.00	8.	*	2	1910	260	.00	.00	.00	0.
1	1820	111	.01	.01	.00	8.	*	2	1920	261	.00	.00	.00	0.
1	1830	112	.01	.01	.00	8.	*	2	1930	262	.00	.00	.00	0.
1	1840	113	.01	.01	.00	8.	*	2	1940	263	.00	.00	.00	0.
1	1850	114	.01	.01	.00	8.	*	2	1950	264	.00	.00	.00	0.
1	1900	115	.01	.01	.00	8.	*	2	2000	265	.00	.00	.00	0.
1	1910	116	.01	.01	.00	8.	*	2	2010	266	.00	.00	.00	0.
1	1920	117	.01	.01	.00	8.	*	2	2020	267	.00	.00	.00	0.
1	1930	118	.01	.01	.00	8.	*	2	2030	268	.00	.00	.00	0.
1	1940	119	.01	.01	.00	8.	*	2	2040	269	.00	.00	.00	0.
1	1950	120	.01	.01	.00	8.	*	2	2050	270	.00	.00	.00	0.
1	2000	121	.01	.01	.00	8.	*	2	2100	271	.00	.00	.00	0.
1	2010	122	.01	.01	.00	8.	*	2	2110	272	.00	.00	.00	0.
1	2020	123	.01	.01	.00	8.	*	2	2120	273	.00	.00	.00	0.
1	2030	124	.01	.01	.00	8.	*	2	2130	274	.00	.00	.00	0.
1	2040	125	.01	.01	.00	8.	*	2	2140	275	.00	.00	.00	0.
1	2050	126	.01	.01	.00	8.	*	2	2150	276	.00	.00	.00	0.
1	2100	127	.01	.01	.00	8.	*	2	2200	277	.00	.00	.00	0.
1	2110	128	.00	.00	.00	8.	*	2	2210	278	.00	.00	.00	0.
1	2120	129	.00	.00	.00	8.	*	2	2220	279	.00	.00	.00	0.
1	2130	130	.00	.00	.00	8.	*	2	2230	280	.00	.00	.00	0.
1	2140	131	.00	.00	.00	8.	*	2	2240	281	.00	.00	.00	0.
1	2150	132	.00	.00	.00	7.	*	2	2250	282	.00	.00	.00	0.
1	2200	133	.00	.00	.00	7.	*	2	2300	283	.00	.00	.00	0.
1	2210	134	.00	.00	.00	7.	*	2	2310	284	.00	.00	.00	0.
1	2220	135	.00	.00	.00	7.	*	2	2320	285	.00	.00	.00	0.
1	2230	136	.00	.00	.00	7.	*	2	2330	286	.00	.00	.00	0.
1	2240	137	.00	.00	.00	7.	*	2	2340	287	.00	.00	.00	0.
1	2250	138	.00	.00	.00	7.	*	2	2350	288	.00	.00	.00	0.
1	2300	139	.00	.00	.00	6.	*	3	0000	289	.00	.00	.00	0.
1	2310	140	.00	.00	.00	6.	*	3	0010	290	.00	.00	.00	0.
1	2320	141	.00	.00	.00	6.	*	3	0020	291	.00	.00	.00	0.
1	2330	142	.00	.00	.00	6.	*	3	0030	292	.00	.00	.00	0.
1	2340	143	.00	.00	.00	6.	*	3	0040	293	.00	.00	.00	0.
1	2350	144	.00	.00	.00	6.	*	3	0050	294	.00	.00	.00	0.
2	0000	145	.00	.00	.00	6.	*	3	0100	295	.00	.00	.00	0.
2	0010	146	.00	.00	.00	6.	*	3	0110	296	.00	.00	.00	0.
2	0020	147	.00	.00	.00	5.	*	3	0120	297	.00	.00	.00	0.
2	0030	148	.00	.00	.00	5.	*	3	0130	298	.00	.00	.00	0.
2	0040	149	.00	.00	.00	4.	*	3	0140	299	.00	.00	.00	0.
2	0050	150	.00	.00	.00	4.	*	3	0150	300	.00	.00	.00	0.

TOTAL RAINFALL = 1.50, TOTAL LOSS = 1.33, TOTAL EXCESS = .17

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	49.83-HR
(CFS)	(HR)	(CFS)				
8.	21.00		8.	4.	2.	2.
		(INCHES)	.085	.168	.169	.169
		(AC-FT)	4.	8.	8.	8.

CUMULATIVE AREA = .87 SQ MI

1

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	INFLOW	8.	21.00	8.	4.	2.	.87		

*** NORMAL END OF HEC-1 ***

SST - RR MATLS - SED BASIN F GULCH S-1

X-SECTIONS AND CUT & FILL V

JANUARY 27, 1998
G. FISCHER
MAXIM

STATION (FT)		ELEVATIONS AT X-SEC STATIONS																	CUT & FILL VOLUMES TOTAL AREAS (SF)	TOTAL AREAS (SY)	VOLUMES (CY)	CUMULATIVE VOLUMES (CY)
0	DISTANCE	00	00	00	00	00	00															
	EXISTING EL	00	00	00	00	00	00															
	NEW EL	00	00	00	00	00	00															
	DIFFERENCE	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	FILL EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	FILL AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00 CUT
23	DISTANCE	73 0	110 0	116 0	121 0	127 0	131 0	134 0	140 0	145 0	152 0	163 0	168 0	00	00	00	00	00				00 FILL
	EXISTING EL	34 0	35 0	34 0	34 0	34 3	34 0	33 8	34 2	34 6	35 1	36 2	36 0	00	00	00	00	00				
	NEW EL	34 0	34 0	30 0	29 0	26 0	26 0	28 0	30 0	32 0	36 0	36 0	00	00	00	00	00	00				
	DIFFERENCE	00	-1 0	-4 0	-5 0	-8 3	-8 0	-7 8	-8 2	-4 6	-3 1	-0 2	00	00	00	00	00	00				
	CUT EL	00	1 0	4 0	5 0	8 3	8 0	7 8	8 2	4 6	3 1	0 2	00	00	00	00	00	00				
	FILL EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT AREA	00	18 5	17 4	28 5	44 7	34 6	25 2	42 0	32 4	23 1	18 2	9 5	00	00	00	00	00				
	FILL AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	295 1	31 7	121 4	121 4 CUT
33	DISTANCE	72 0	104 0	107 0	111 0	115 0	118 0	121 0	125 0	129 0	140 0	142 0	146 0	150 0	154 0	158 0	162 0	166 0				00 FILL
	EXISTING EL	34 0	35 0	34 0	34 0	34 4	34 2	34 0	33 8	33 5	33 9	34 3	34 7	35 1	35 5	35 9	36 2	36 6				
	NEW EL	34 0	34 0	32 0	30 0	26 0	26 0	25 0	25 0	25 0	25 0	25 0	25 0	30 0	32 0	34 0	36 0	36 0				
	DIFFERENCE	00	-1 0	-2 0	-4 0	-8 4	-8 2	-9 0	-8 8	-8 5	-8 9	-8 3	-8 7	-5 1	-3 5	-1 9	-0 2	00				
	CUT EL	00	1 0	2 0	4 0	8 4	8 2	9 0	8 8	8 5	8 9	8 3	8 7	5 1	3 5	1 9	0 2	00				
	FILL EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT AREA	00	16 8	6 7	14 8	22 0	29 2	17 2	35 8	13 1	8 7	17 2	30 0	23 6	17 2	10 8	4 2	00				
	FILL AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	373 9	41 5	100 8	231 2 CUT
120	DISTANCE	80 0	84 0	88 0	96 0	103 8	110 0	117 0	120 0	125 0	130 0	137 0	140 0	143 0	150 0	157 0	164 0	170 0	172 0			00 FILL
	EXISTING EL	30 0	30 0	30 5	31 0	31 6	32 0	32 1	32 0	30 0	29 5	30 0	31 0	31 5	33 0	33 5	33 7	33 5	33 5			
	NEW EL	30 0	30 0	32 0	32 0	30 8	29 0	26 0	25 0	25 0	25 0	25 0	25 0	25 0	26 0	28 0	30 0	32 0	32 0	33 5		
	DIFFERENCE	00	00	1 5	1 0	-1 8	-3 0	-6 1	-7 0	-5 0	-4 5	-5 0	-6 0	-6 0	-5 5	-5 0	-3 5	-1 7	-1 5	00		
	CUT EL	00	00	00	00	1 8	3 0	6 1	7 0	5 0	4 5	5 0	6 0	6 0	5 5	5 0	3 5	1 7	1 5	00		
	FILL EL	00	00	1 5	1 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00		
	CUT AREA	00	00	00	00	5 3	19 3	35 4	19 7	30 0	23 8	33 3	16 5	17 3	38 8	29 8	18 2	8 8	1 8	296 1	32 9	1091 8	1323 0 CUT
	FILL AREA	00	00	3 8	8 8	3 5	00	00	00	00	00	00	00	00	00	00	00	00	00	16 0	1 8	26 1	26 1 FILL
161	DISTANCE	31 0	50 0	57 0	82 8	105 0	120 0	129 0	142 0	156 0	174 0	178 0	185 0	192 0	199 0	205 0	210 0	214 0	214 0			
	EXISTING EL	25 0	26 0	26 4	27 0	28 5	28 0	25 8	28 0	30 0	30 0	29 8	29 6	29 4	29 2	29 0	28 8	28 8	28 6			
	NEW EL	25 0	32 0	32 0	25 0	25 0	25 0	25 0	25 0	25 0	25 0	26 0	26 0	30 0	32 0	32 0	30 0	30 0	28 6			
	DIFFERENCE	00	6 0	5 6	-2 8	-3 5	-3 0	-0 8	-3 0	-5 0	-5 0	-3 8	-1 8	0 6	2 8	3 0	1 2	1 2	0 0			
	CUT EL	00	00	00	2 8	3 5	3 0	0 8	3 0	5 0	5 0	3 8	1 8	00	00	00	00	00	00			
	FILL EL	00	6 0	5 6	00	00	00	00	00	00	00	00	00	0 6	2 8	3 0	1 2	1 2	0 0			
	CUT AREA	00	00	00	36 2	73 8	48 8	17 1	24 7	56 0	90 0	17 5	18 9	5 6	0 0	0 0	0 0	0 0	0 0	386 5	43 2	773 3	2096 3 CUT
	FILL AREA	00	67 0	40 6	70 0	0 0	0 0	00	00	0 0	0 0	00	00	2 1	11 9	17 4	10 5	4 8	0 0	214 3	23 8	260 2	260 2 FILL
205	DISTANCE	11 0	17 0	21 0	27 0	31 0	36 0	57 0	99 0	115 0	120 0	128 0	137 0	146 0	154 0	219 0	223 0	228 0	233 0			
	EXISTING EL	23 8	24 0	24 4	24 8	25 2	25 6	26 0	26 0	28 0	26 0	24 5	26 0	26 0	28 0	27 0	27 0	27 0	27 0			
	NEW EL	23 8	24 0	26 0	28 0	30 8	32 0	32 0	32 0	32 0	32 0	32 0	32 0	32 0	32 0	32 0	30 0	28 0	27 0			
	DIFFERENCE	00	00	1 6	3 2	4 8	6 4	6 0	6 0	4 0	6 0	7 5	6 0	6 0	4 0	5 0	3 0	1 0	0 0			
	CUT EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00			
	FILL EL	00	00	1 6	3 2	4 8	6 4	6 0	6 0	4 0	6 0	7 5	6 0	6 0	4 0	5 0	3 0	1 0	0 0			
	CUT AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	0 0	0 0	172 7	2269 0 CUT
	FILL AREA	00	6 0	3 2	14 4	16 0	29 0	130 2	210 0	64 0	25 0	54 0	80 8	45 0	32 0	292 5	16 0	10 0	2 5	1003 6	111 5	541 3	827 5 FILL
226	DISTANCE	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00			
	EXISTING EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00			
	NEW EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00			
	DIFFERENCE	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00			
	CUT EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00			
	FILL EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00			
	CUT AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	2269 0 CUT
	FILL AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	371 7	1190 2 FILL
0	DISTANCE	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00						
	EXISTING EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00						
	NEW EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00						
	DIFFERENCE	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00						
	CUT EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00			
	FILL EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00			
	CUT AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00			
	FILL AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	2269 0 CUT
																				00	00	00	1190 2 FILL

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SST - RR MATL9 - RED BARN POR C1d

FEBRUARY 8, 1996
G FISCHER
MAXIM

X-SECTIONS AND CUT & FILL VOLUM

STATION (FT)	ELEV.	STATIONS																		CUT & FILL VOLU			
																				TOTAL AREA (SF)	TC (BY)	VOLUMES (CY)	CUMULATIVE VOLUMES (CY)
0 DISTANCE																							
EXISTING EL																							
NEW EL																							
DIFFERENCE																							
CUT EL																							
FILL EL																							
CUT AREA																							
FILL AREA																							
0																				0.0	0.0	0.0	0.0 CUT
																				0.0	0.0	0.0	0.0 FILL
66 DISTANCE																							
EXISTING EL																							
NEW EL																							
DIFFERENCE																							
CUT EL																							
FILL EL																							
CUT AREA																							
FILL AREA																							
66																				390.3	36.9	431.8	431.8 CUT
																				0.0	0.0	0.0	0.0 FILL
74 DISTANCE																							
EXISTING EL																							
NEW EL																							
DIFFERENCE																							
CUT EL																							
FILL EL																							
CUT AREA																							
FILL AREA																							
139 DISTANCE																				933.8	37.1	114.8	916.6 CUT
EXISTING EL																				0.0	0.0	0.0	0.0 FILL
NEW EL																							
DIFFERENCE																							
CUT EL																							
FILL EL																							
CUT AREA																							
FILL AREA																							
153 DISTANCE																				486.0	64.3	700.9	1236.5 CUT
EXISTING EL																				0.0	0.0	0.0	0.0 FILL
NEW EL																							
DIFFERENCE																							
CUT EL																							
FILL EL																							
CUT AREA																							
FILL AREA																							
173 DISTANCE																				270.0	36.0	448.7	1705.3 CUT
EXISTING EL																				0.0	0.0	64.4	64.4 FILL
NEW EL																							
DIFFERENCE																							
CUT EL																							
FILL EL																							
CUT AREA																							
FILL AREA																							
186 DISTANCE																				120.8	13.4	147.8	1853.0 CUT
EXISTING EL																				238.8	36.7	131.8	176.2 FILL
NEW EL																							
DIFFERENCE																							
CUT EL																							
FILL EL																							
CUT AREA																							
FILL AREA																							
0																				0.0	0.0	0.0	1906.8 CUT
206 DISTANCE																				70.8	7.8	143.8	319.7 FILL
EXISTING EL																							
NEW EL																							
DIFFERENCE																							
CUT EL																							
FILL EL																							
CUT AREA																							
FILL AREA																							
0																				0.0	0.0	0.0	1906.8 CUT
																				0.0	0.0	33.7	353.4 FILL

S-3

SST - RR MATL.B - SED BASIN F

X-SECTIONS AND CUT & FILL V

FEBRUARY 6, 1998
G. FISCHER
MAXIM

STATION (FT)		ELEVATIONS AT X-SEC STATIONS																	CUT & FILL VOLUMES TOTAL AREAS (SF)	TOTAL AREAS (SY)	VOLUMES (CY)	CUMULATIVE VOLUMES (CY)
0	DISTANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	EXISTING EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	NEW EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	DIFFERENCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	FILL EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	FILL AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 CUT
																			0.0	0.0	0.0	0.0 FILL
40	DISTANCE	22.8	33.0	55.8	70.8	75.8	90	90	90	90	90	90	90	90	90	90	90	90				
	EXISTING EL	34.0	32.5	29.0	31.0	32.0	90	90	90	90	90	90	90	90	90	90	90	90				
	NEW EL	34.0	32.0	23.0	30.0	32.0	90	90	90	90	90	90	90	90	90	90	90	90				
	DIFFERENCE	0.0	-0.5	-6.0	-1.0	0.0	90	90	90	90	90	90	90	90	90	90	90	90				
	CUT EL	0.0	0.5	6.0	1.0	0.0	90	90	90	90	90	90	90	90	90	90	90	90				
	FILL EL	0.0	0.0	0.0	0.0	0.0	90	90	90	90	90	90	90	90	90	90	90	90				
	CUT AREA	0.0	2.8	71.5	52.5	2.5	90	90	90	90	90	90	90	90	90	90	90	90				
	FILL AREA	0.0	0.0	0.0	0.0	0.0	90	90	90	90	90	90	90	90	90	90	90	90	129.3	14.4	98.7	98.7 CUT
																			0.0	0.0	0.0	0.0 FILL
72	DISTANCE	11.0	26.0	38.0	52.0	73.0	97.0	104.0	106.0	90	90	90	90	90	90	90	90	90				
	EXISTING EL	30.0	29.5	28.5	25.5	28.5	29.0	29.0	29.0	90	90	90	90	90	90	90	90	90				
	NEW EL	30.5	28.0	23.0	23.0	23.0	30.0	30.0	29.0	90	90	90	90	90	90	90	90	90				
	DIFFERENCE	0.5	-1.5	-5.5	-2.5	-5.5	1.0	1.0	0.0	90	90	90	90	90	90	90	90	90				
	CUT EL	0.0	1.5	5.5	2.5	5.5	0.0	0.0	0.0	90	90	90	90	90	90	90	90	90				
	FILL EL	0.0	0.0	0.0	0.0	0.0	1.0	1.0	0.0	90	90	90	90	90	90	90	90	90				
	CUT AREA	0.0	11.3	42.0	56.0	84.0	84.0	0.0	0.0	90	90	90	90	90	90	90	90	90				
	FILL AREA	0.0	0.0	0.0	0.0	0.0	12.0	7.0	1.0	90	90	90	90	90	90	90	90	90	259.3	28.8	230.2	328.8 CUT
																			20.0	2.2	11.9	11.9 FILL
94	DISTANCE	13.0	18.0	53.0	92.0	100.0	90	90	90	90	90	90	90	90	90	90	90	90				
	EXISTING EL	29.0	27.8	23.5	27.0	27.0	90	90	90	90	90	90	90	90	90	90	90	90				
	NEW EL	29.0	30.0	30.0	30.0	27.0	90	90	90	90	90	90	90	90	90	90	90	90				
	DIFFERENCE	0.0	2.5	6.5	3.0	0.0	90	90	90	90	90	90	90	90	90	90	90	90				
	CUT EL	0.0	0.0	0.0	0.0	0.0	90	90	90	90	90	90	90	90	90	90	90	90				
	FILL EL	0.0	2.5	6.5	3.0	0.0	90	90	90	90	90	90	90	90	90	90	90	90				
	CUT AREA	0.0	0.0	0.0	0.0	0.0	90	90	90	90	90	90	90	90	90	90	90	90				
	FILL AREA	0.0	6.3	157.5	165.3	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	431.8 CUT
																			361.0	40.1	155.2	167.1 FILL
118	DISTANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	EXISTING EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	NEW EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	DIFFERENCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	FILL EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	FILL AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	431.8 CUT
																			0.0	0.0	140.4	307.5 FILL

S-4 west

AST - RR MATLS - SED BASIN PD

X-SECTIONS AND CUT & FILL VC

FEBRUARY 9, 1996
G. FISCHER
MARIN

STATION (FT) EL. AT X-SEC STATIONS

																					CUT & FILL VOLUMES			
																					TOTAL AREAS (SF)	TOTAL AREAS (SY)	VOLUMES (CY)	CUMULATIVE VOLUMES (CY)
0	DISTANCE	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	EXISTING EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	NEW EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	DIFFERENCE	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	FILL EL	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	FILL AREA	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
37	DISTANCE	66 0	66 0	67 0	107 0	126 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	EXISTING EL	33 0	33 0	26 0	33 0	34 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	NEW EL	33 0	32 0	33 0	32 0	34 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	DIFFERENCE	00	-1 0	-6 0	-1 0	0 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT EL	00	1 0	0 0	1 0	0 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	FILL EL	00	0 0	6 0	0 0	0 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT AREA	00	0 0	0 0	0 0	0 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	FILL AREA	00	0 0	66 0	7 0	0 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
																					0 0	0 0	0 0	0 0 CUT
																					0 0	0 0	0 0	0 0 FILL
48	DISTANCE	66 0	66 0	61 0	81 0	107 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	EXISTING EL	29 0	29 3	26 0	29 0	37 3	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	NEW EL	29 5	30 0	32 6	32 0	35 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	DIFFERENCE	00	0 3	5 3	4 0	2 7	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT EL	00	0 0	0 0	0 0	0 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	FILL EL	00	0 0	3 2	0 0	0 0	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT AREA	00	0 0	0 0	4 0	2 7	00	00	00	00	00	00	00	00	00	00	00	00	00	00				
	FILL AREA	00	4 4	30 0	30 0	63 0	-144 4	00	00	00	00	00	00	00	00	00	00	00	00	00				
																					176 3	19 6	120 6	120 6 CUT
																					0 0	0 0	0 0	0 0 FILL
56	DISTANCE	0 0	0 0	17 0	71 0	90 0	64 0	100 0	111 0	123 0	00	00	00	00	00	00	00	00	00	00				
	EXISTING EL	31 0	31 0	30 0	30 0	28 5	30 0	27 5	28 0	28 0	00	00	00	00	00	00	00	00	00	00				
	NEW EL	31 0	30 0	27 0	27 0	23 0	23 0	27 0	30 0	30 0	00	00	00	00	00	00	00	00	00	00				
	DIFFERENCE	0 0	-1 0	-3 0	-3 0	-5 5	-7 0	-0 5	2 0	2 0	00	00	00	00	00	00	00	00	00	00				
	CUT EL	00	1 0	3 5	0 0	0 0	0 0	0 0	0 0	0 0	00	00	00	00	00	00	00	00	00	00				
	FILL EL	00	0 0	0 0	3 0	5 5	7 0	0 5	0 0	0 0	00	00	00	00	00	00	00	00	00	00				
	CUT AREA	00	0 0	16 5	148 5	42 5	35 5	4 0	2 0	0 0	00	00	00	00	00	00	00	00	00	00				
	FILL AREA	00	0 0	0 0	0 0	0 0	0 0	0 0	11 0	12 0	00	00	00	00	00	00	00	00	00	00				
																					784 0	31 6	47 3	307 3 CUT
																					33 0	3 0	0 4	4 1 FILL
64	DISTANCE	0 0	16 5	22 0	56 0	66 0	107 0	118 0	123 0	0 0	00	00	00	00	00	00	00	00	00	00				
	EXISTING EL	25 0	24 7	23 3	30 0	29 7	27 2	25 0	25 7	0 0	00	00	00	00	00	00	00	00	00	00				
	NEW EL	24 5	26 5	25 5	58 0	32 0	32 0	32 0	32 0	0 0	00	00	00	00	00	00	00	00	00	00				
	DIFFERENCE	0 0	1 3	2 7	4 0	2 3	4 8	7 0	6 3	0 0	00	00	00	00	00	00	00	00	00	00				
	CUT EL	0 0	0 0	0 0	0 0	0 0	0 0	4 8	3 3	0 0	00	00	00	00	00	00	00	00	00	00				
	FILL EL	0 0	1 3	2 7	4 0	2 3	4 8	0 0	0 0	0 0	00	00	00	00	00	00	00	00	00	00				
	CUT AREA	0 0	0 0	0 0	0 0	0 0	0 0	4 8	3 3	0 0	00	00	00	00	00	00	00	00	00	00				
	FILL AREA	0 0	0 0	4 8	24 0	83 8	188 0	66 0	0 0	0 0	00	00	00	00	00	00	00	00	00	00				
									35 2	25 6	-301 5										0 0	0 0	31 6	238 8 CUT
																					393 6	36 2	36 7	36 8 FILL
81	DISTANCE	2 6	7 6	20 0	66 6	87 0	112 0	00	00	00	00	00	00	00	00	00	00	00	00	00				
	EXISTING EL	25 0	26 6	27 7	26 5	27 0	26 5	00	00	00	00	00	00	00	00	00	00	00	00	00				
	NEW EL	25 6	26 0	30 0	35 6	30 0	30 5	00	00	00	00	00	00	00	00	00	00	00	00	00				
	DIFFERENCE	0 0	1 0	2 3	1 0	3 0	3 5	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT EL	0 0	0 0	0 0	0 0	0 0	0 0	00	00	00	00	00	00	00	00	00	00	00	00	00				
	FILL EL	0 0	1 0	2 3	1 0	3 0	3 5	00	00	00	00	00	00	00	00	00	00	00	00	00				
	CUT AREA	0 0	0 0	0 0	0 0	0 0	0 0	00	00	00	00	00	00	00	00	00	00	00	00	00				
	FILL AREA	0 0	2 6	34 7	61 3	90 0	97 5	00	00	00	00	00	00	00	00	00	00	00	00	00				
																					0 0	0 0	0 0	238 8 CUT
																					205 8	22 8	144 6	171 2 FILL
93	DISTANCE	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0				
	EXISTING EL	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0				
	NEW EL	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0				
	DIFFERENCE	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0				
	CUT EL	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0				
	FILL EL	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0				
	CUT AREA	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0				
	FILL AREA	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0				
																					0 0	0 0	0 0	316 8 CUT
																					0 0	0 0	48 7	216 8 FILL

S-4 (East)

SST : RR MATLS - BED BASIN F

X-SECTIONS AND CUT & FILL \

FEBRUARY 8, 1998
G FISCHER
MAXIM

STATION (FT)		ELEVATIONS AT X-SEC STATIONS																		CUT & FILL VOLUMES TOTAL AREAS (SF)	TOTAL AREAS (SY)	VOLUMES (CY)	CUMULATIVE VOLUMES (CY)
0	DISTANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	EXISTING EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	NEW EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	DIFFERENCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	FILL EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 CUT
	FILL AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 FILL
24	DISTANCE	21.0	26.0	29.0	30.5	35.0	37.5	40.0	44.5	45.5	48.5	50.0	53.0	57.5	0.0	0.0	0.0	0.0	0.0				
	EXISTING EL	32.0	30.5	30.0	29.5	28.5	28.7	29.3	29.8	30.0	31.3	32.0	32.8	34.0	0.0	0.0	0.0	0.0	0.0				
	NEW EL	32.0	30.0	29.7	29.0	28.0	25.0	26.0	26.0	29.5	30.0	30.8	32.0	34.0	0.0	0.0	0.0	0.0	0.0				
	DIFFERENCE	0.0	-0.5	-1.3	-1.5	-2.5	-3.7	-3.3	-1.5	-1.5	-1.3	-1.2	-0.8	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT EL	0.0	0.5	1.3	1.5	2.5	3.7	3.3	1.5	1.5	1.3	1.2	0.8	0.0	0.0	0.0	0.0	0.0	0.0				
	FILL EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT AREA	0.0	2.0	3.2	2.3	10.5	8.2	8.8	11.5	1.7	4.2	1.9	3.0	1.5	0.0	0.0	0.0	0.0	0.0	59.1	6.6	26.2	26.2 CUT
	FILL AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 FILL
37	DISTANCE	16.5	15.0	18.5	20.0	24.0	26.0	29.0	38.0	48.0	51.0	55.0	59.5	63.0	0.0	0.0	0.0	0.0	0.0				
	EXISTING EL	34.0	32.5	32.0	31.7	30.4	30.6	29.1	28.2	28.9	29.9	32.0	32.8	33.7	0.0	0.0	0.0	0.0	0.0				
	NEW EL	34.0	32.0	30.5	30.0	29.0	27.3	26.0	26.0	26.0	26.0	30.1	32.0	33.7	0.0	0.0	0.0	0.0	0.0				
	DIFFERENCE	0.0	-0.5	-1.5	-1.7	-2.4	-2.7	-3.1	-2.2	-2.9	-1.9	-1.9	-0.8	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT EL	0.0	0.5	1.5	1.7	2.4	2.7	3.1	2.2	2.9	1.9	1.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0				
	FILL EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT AREA	0.0	2.5	4.2	2.4	8.2	5.1	8.7	23.8	20.4	12.0	7.6	6.1	1.4	0.0	0.0	0.0	0.0	0.0	101.9	11.3	37.3	63.5 CUT
	FILL AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0 FILL
56	DISTANCE	15.0	22.0	31.0	37.5	43.5	52.0	54.0	64.0	67.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	EXISTING EL	32.0	30.0	29.0	27.2	29.0	29.6	30.0	31.0	32.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	NEW EL	32.0	32.0	32.0	32.0	32.0	32.0	31.0	31.0	32.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	DIFFERENCE	0.0	2.0	4.0	4.8	4.0	2.4	1.0	-0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	FILL EL	0.0	2.0	4.0	4.8	4.0	2.4	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	0.4	37.8	101.3 CUT
	FILL AREA	0.0	7.0	27.0	26.6	26.4	27.2	34	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.6	13.8	44.5	44.5 FILL
74	DISTANCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	EXISTING EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	NEW EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	DIFFERENCE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	FILL EL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				
	CUT AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	102.6 CUT
	FILL AREA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	41.3	85.8 FILL

MAXIM TECHNOLOGIES INC

Maxim Technologies
1610 B Street. PO Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2462
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/18/98

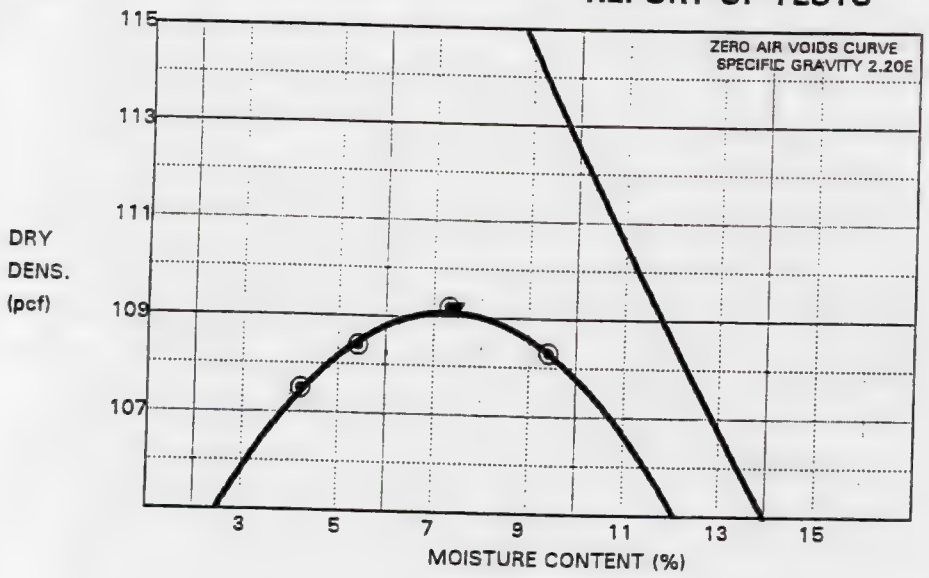
SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: SB-WG-01; 1'-2'
Basin S-1

TEST DATE: 2/17/98
MATERIAL: NATIVE
CLASSIFICATION: POORLY GRADED SAND
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-A

REPORT OF TESTS



MAXIMUM DENSITY, PCF:	109.0
OPTIMUM MOISTURE (%):	7.5
% PASSING 3/4:	98.0
% PASSING 3/8:	95.0
% PASSING #4:	89.0
% PASSING #40:	33.0
% PASSING #200:	4.7

E = Estimated Value

Report Of Tests Continued On Page 2

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MAXIM

DEPT. ENVIRONMENTAL QUALITY
PROJECT NO. 9731701
DATE OF SERVICE: 2/16/98

REPORT NO. 2462
PAGE 2 OF 2

REPORT OF TESTS

BASIN S-1

ADDITIONAL COMMENTS:

SB-WG-01
1' - 2'
1/28/98
LAB NO. 2462-1

SIEVE ANALYSIS Sieve Size	PERCENT PASSING
1 1/2"	100
1"	99
3/4"	98
1/2"	96
3/8"	95
NO. 4	89
NO. 10	80
NO. 20	57
N0. 40	33
N0. 80	11
N0. 200	4.7

Technician: Steve Whitford
Engineering Technician

Report Distribution:
GARY FISCHER
TODD KUXHAUS

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser, P.E.
Engineering Manager

1008

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1610 B Street. PO Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2463
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/17/98

SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

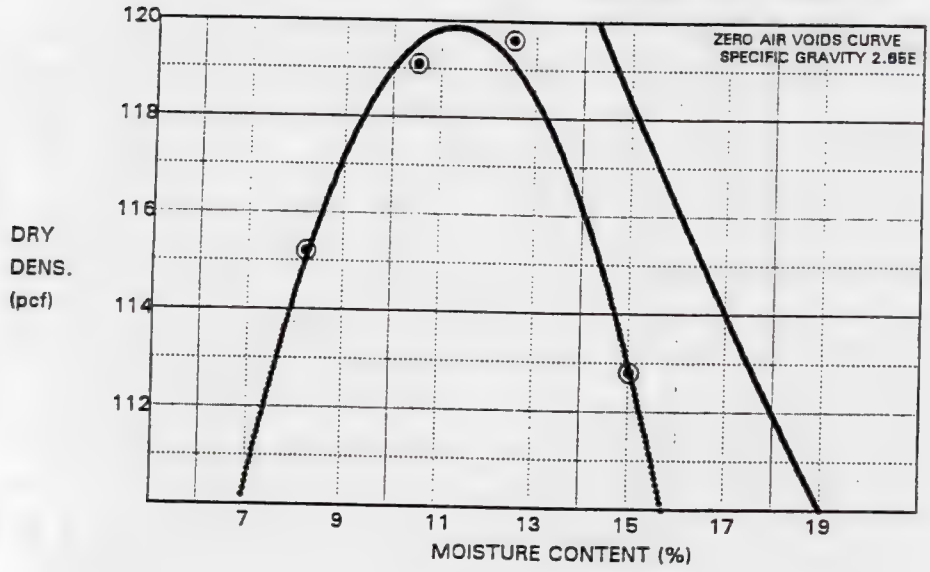
PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: SB-C1/C2/C4-01; 1'-2'

Basin S-2

TEST DATE: 2/16/98
MATERIAL: NATIVE
CLASSIFICATION: SILTY SAND
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-A

REPORT OF TESTS



MAXIMUM DENSITY, PCF:	120.0
OPTIMUM MOISTURE (%):	11.5
% PASSING 3/4:	100.0
% PASSING 3/8:	99.0
% PASSING #4:	96.0
% PASSING #40:	46.0
% PASSING #200:	22.0

E = Estimated Value

Report Of Tests Continued On Page 2

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MAXIM

DEPT. ENVIRONMENTAL QUALITY
PROJECT NO. 9731701
DATE OF SERVICE: 2/16/98

REPORT NO. 2463
PAGE 2 OF 2

REPORT OF TESTS

ADDITIONAL COMMENTS:

Basin S-2

SB-C1/C2/C4-01
1' - 2'
1/28/98
LAB NO. 2463-1

SIEVE ANALYSIS

Sieve Size	PERCENT PASSING
1/2"	100
3/8"	99
NO. 4	96
NO. 10	86
NO. 20	65
NO. 40	47
NO. 80	31
NO. 200	22

Technician: Jesse Whitford
Engineering Technician

Report Distribution:

*) GARY FISCHER
TODD KUXHAUS

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser, P.E.
Engineering Manager

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Maxim Technologies
1610 B Street. PO Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2465
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/18/98

SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

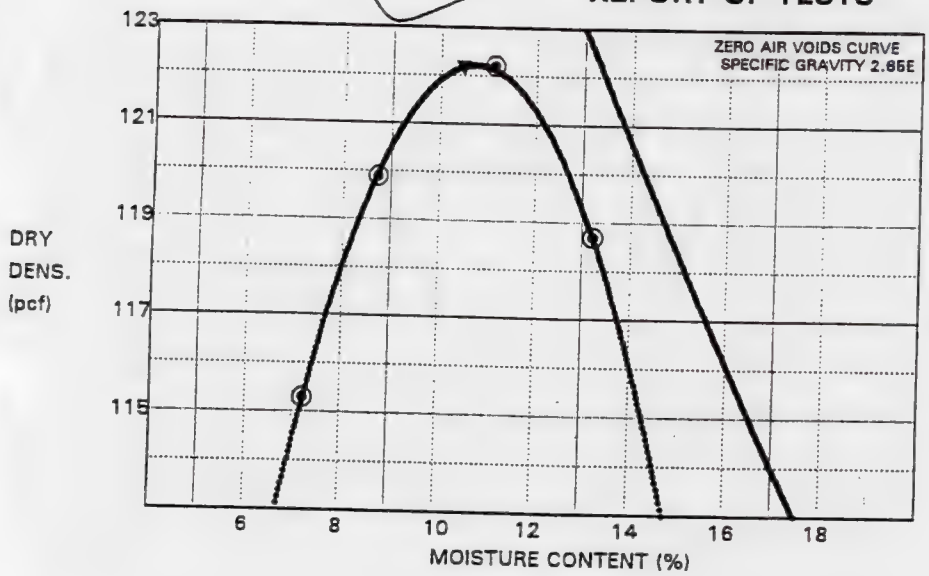
PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: SB-C5.5-1; 1'-2'

Basin 5-3

TEST DATE: 2/12/98
MATERIAL: NATIVE
CLASSIFICATION: SILTY SAND
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-A

REPORT OF TESTS



MAXIMUM DENSITY, PCF:	122.0
OPTIMUM MOISTURE (%):	10.5
% PASSING 3/8:	100.0
% PASSING #4:	96.0
% PASSING #40:	39.0
% PASSING #200:	20.0

E = Estimated Value

Report Of Tests Continued On Page 2

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MAXIM

DEPT. ENVIRONMENTAL QUALITY
PROJECT NO. 9731701
DATE OF SERVICE: 2/16/98

REPORT OF TESTS

ADDITIONAL COMMENTS:

SB-C5.5-1
1' - 2'
1/28/98
LAB NO. 2465-1

SIEVE ANALYSIS Sieve Size	PERCENT PASSING
3/8"	100
NO. 4	96
NO. 10	81
NO. 20	55
NO. 40	39
NO. 80	27
NO. 200	20

Technician: Steve Whitford
Engineering Technician

Report Distribution:
ARY FISCHER
ODD KUXHAUS

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser, P.E.
Engineering Manager

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MAXIM TECHNOLOGIES INC

Maxim Technologies
1610 B Street. PO Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2466
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/18/98

SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

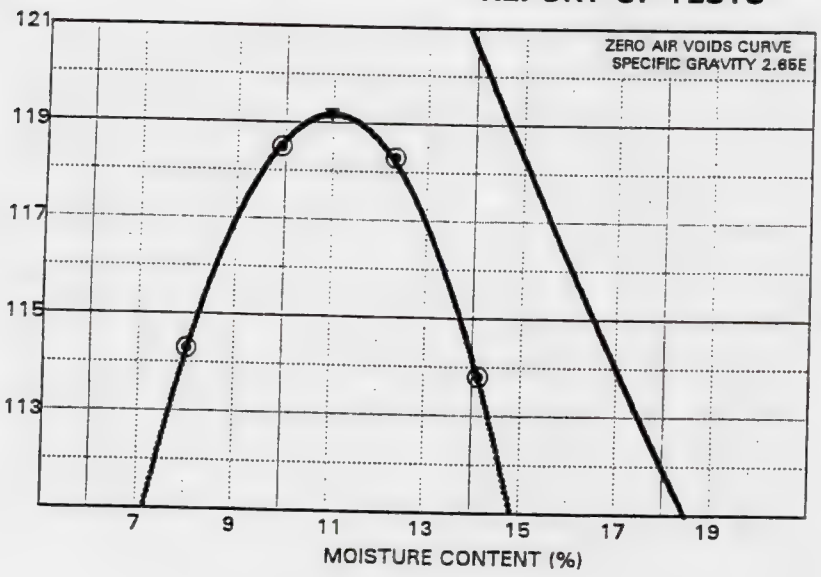
PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: SB-C7/C10-01; 1'-2'

Basin 3-4 east

TEST DATE: 2/11/98
MATERIAL: NATIVE
CLASSIFICATION: SILTY SAND
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-A

REPORT OF TESTS



MAXIMUM DENSITY, PCF:	119.0
OPTIMUM MOISTURE (%):	11.0
% PASSING 3/8:	100.0
% PASSING #4:	96.0
% PASSING #40:	46.0
% PASSING #200:	21.0

E = Estimated Value

Report Of Tests Continued On Page 2

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MAXIM

DEPT. ENVIRONMENTAL QUALITY
PROJECT NO. 9731701
DATE OF SERVICE: 2/16/98

REPORT OF TESTS

ADDITIONAL COMMENTS:

SB-C7/C10-01
1' - 2'
1/28/98
LAB NO. 2466-1

SIEVE ANALYSIS

Sieve Size	PERCENT PASSING
3/8"	100
NO. 4	96
NO. 10	82
NO. 20	60
NO. 40	46
NO. 80	32
NO. 200	21

Technician: Steve Whitford
Engineering Technician

Report Distribution:

GARY FISCHER
TODD KUXHAUS

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser, P.E.
Engineering Manager

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MAXIM TECHNOLOGIES INC

Maxim Technologies
1610 B Street. PO Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2467
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/18/98

SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

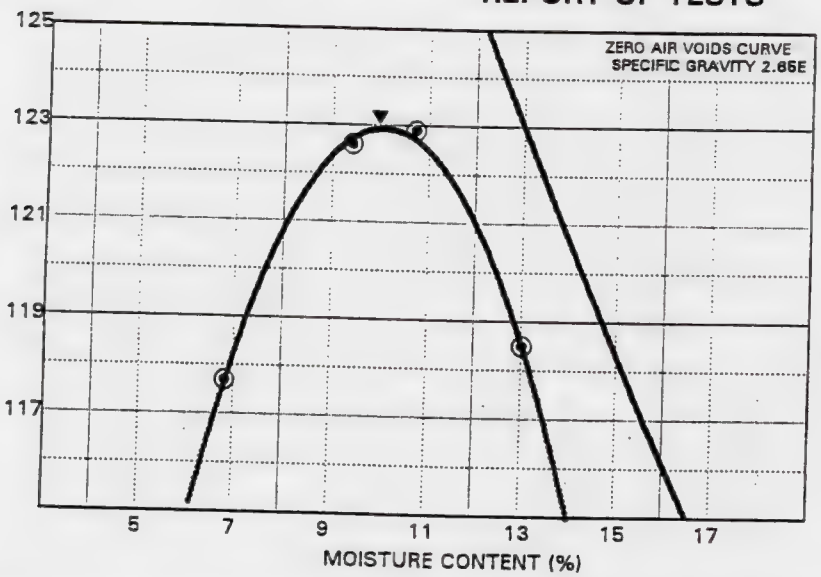
PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: SB-C7/C10-02; 1'-2'

Basins 4 west

TEST DATE: 2/12/98
MATERIAL: NATIVE
CLASSIFICATION: POORLY GRADED SAND W/SILT
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-A

REPORT OF TESTS



MAXIMUM DENSITY, PCF:	123.0
OPTIMUM MOISTURE (%):	10.0
% PASSING 3/4:	94.0
% PASSING 3/8:	92.0
% PASSING #4:	90.0
% PASSING #40:	38.0
% PASSING #200:	13.0

E = Estimated Value

Note: Maximum Density and Optimum Moisture corrected for 10% oversized particles retained on 3/8 sieve in accordance with ASTM D 4718 procedure using a Specific Gravity of 2.49.

Report Of Tests Continued On Page 2

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MAXIM

DEPT. ENVIRONMENTAL QUALITY
PROJECT NO. 9731701
DATE OF SERVICE: 2/16/98

REPORT NO. 2467
PAGE 2 OF 2

REPORT OF TESTS

ADDITIONAL COMMENTS:

SB-C7/C10-02
1' - 2'
1/28/98
LAB NO. 2467-1

SIEVE ANALYSIS Sieve Size	PERCENT PASSING
3"	100
2"	96
1 1/2"	95
1"	94
3/4"	94
1/2"	92
3/8"	92
NO. 4	90
NO. 10	75
NO. 20	54
NO. 40	38
NO. 80	24
NO. 200	13

Technician: Steve Whitford
Engineering Technician

Report Distribution:
GARY FISCHER
TODD KUXHAUS

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser, P.E.
Engineering Manager

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FAX: (406) 449-3729

REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2468
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/18/98

SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

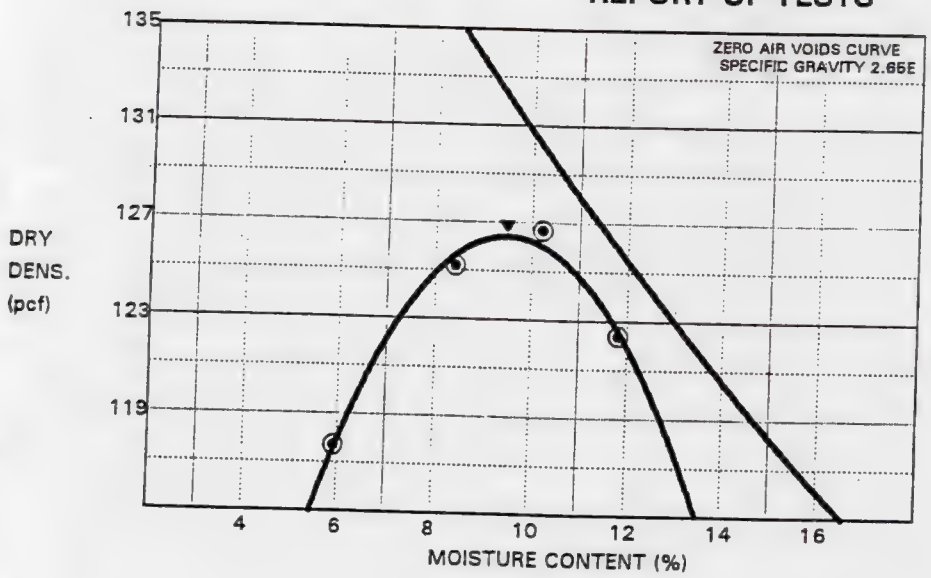
PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: SB-C11/C13-01; 1'-2'

Basin 5-5

TEST DATE: 2/13/98
MATERIAL: NATIVE
CLASSIFICATION: SILTY SAND
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-A

REPORT OF TESTS



MAXIMUM DENSITY, PCF:	126.5
OPTIMUM MOISTURE (%):	9.5
% PASSING 3/4:	100.0
% PASSING 3/8:	99.0
% PASSING #4:	96.0
% PASSING #40:	62.0
% PASSING #200:	25.0

E = Estimated Value

Report Of Tests Continued On Page 2

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MAXIM

DEPT. ENVIRONMENTAL QUALITY
PROJECT NO. 9731701
DATE OF SERVICE: 2/16/98

REPORT OF TESTS

ADDITIONAL COMMENTS:

SB-C11/C13-01
1' - 2'
1/28/98
LAB NO. 2468-1

SIEVE ANALYSIS Sieve Size	PERCENT PASSING
1/2"	100
3/8"	99
NO. 4	96
NO. 10	86
NO. 20	74
NO. 40	62
NO. 80	40
NO. 200	25

Technician: Steve Whitford
Engineering Technician

Report Distribution:
GARY FISCHER
TODD KUXHAUS

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser, P.E.
Engineering Manager

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MAXIM TECHNOLOGIES INC

Maxim Technologies
1610 B Street. PO Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2469
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/18/98

SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

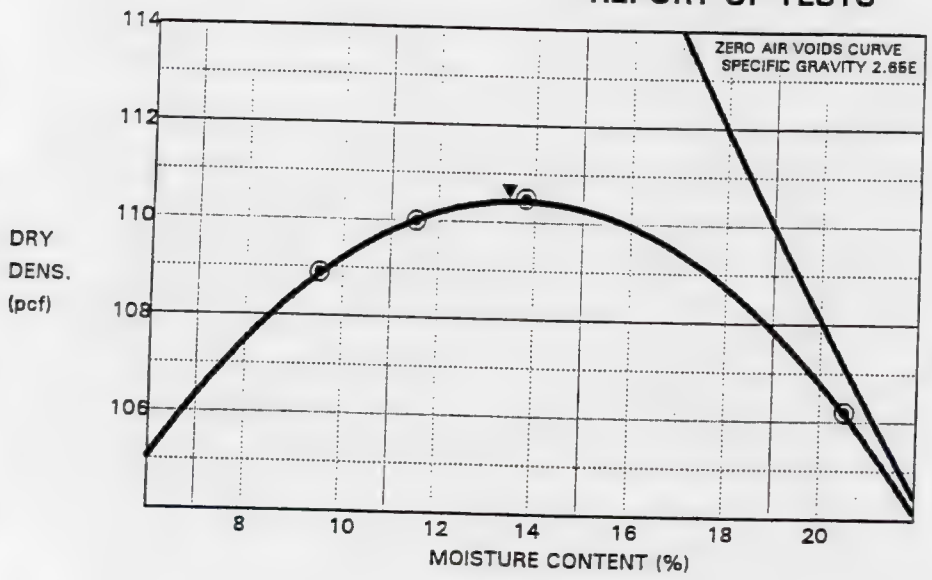
PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: SB-C14-01; 1'-2'

TEST DATE: 2/16/98
MATERIAL: NATIVE
CLASSIFICATION: POORLY GRADED SAND
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-A

Basin 5-6

REPORT OF TESTS



MAXIMUM DENSITY, PCF:	110.5
OPTIMUM MOISTURE (%):	13.5
% PASSING 3/4:	98.0
% PASSING 3/8:	96.0
% PASSING #4:	90.0
% PASSING #40:	12.0
% PASSING #200:	3.1

E = Estimated Value

Report Of Tests Continued On Page 2

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MAXIM

DEPT. ENVIRONMENTAL QUALITY
PROJECT NO. 9731701
DATE OF SERVICE: 2/16/98

REPORT NO. 2469
PAGE 2 OF 2

REPORT OF TESTS

ADDITIONAL COMMENTS:

SB-C14-01
1' - 2'
1/28/98
LAB NO. 2469-1

SIEVE ANALYSIS Sieve Size	PERCENT PASSING
2"	100
1 1/2"	99
1"	99
3/4"	98
1/2"	97
3/8"	96
NO. 4	90
NO. 10	66
NO. 20	28
NO. 40	12
NO. 80	5
NO. 200	3.1

Technician: Steve Whitford
Engineering Technician

Report Distribution:

(1) GARY FISCHER
(1) TODD KUXHAUS

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser, P.E.
Engineering Manager

1008

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MAXIM TECHNOLOGIES INC

Maxim Technologies
1610 B Street. PO Box 4699
Helena, MT 59604
Telephone: (406) 443-5210
FAX: (406) 449-3729

REPORT OF MOISTURE-DENSITY RELATIONS

CLIENT: DEPT. ENVIRONMENTAL QUALITY
C/O MAXIM TECHNOLOGIES
ATTN: CAMERON BUEL
PO BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 9731701
REPORT NO.: 2470
DATE OF SERVICE: 2/16/98
AUTHORIZATION: TODD KUXHAUS
REPORT DATE: 2/18/98

SERVICES: Obtain sample of material used for construction, prepare samples and perform moisture-density relations test to establish the maximum density and optimum moisture of the material.

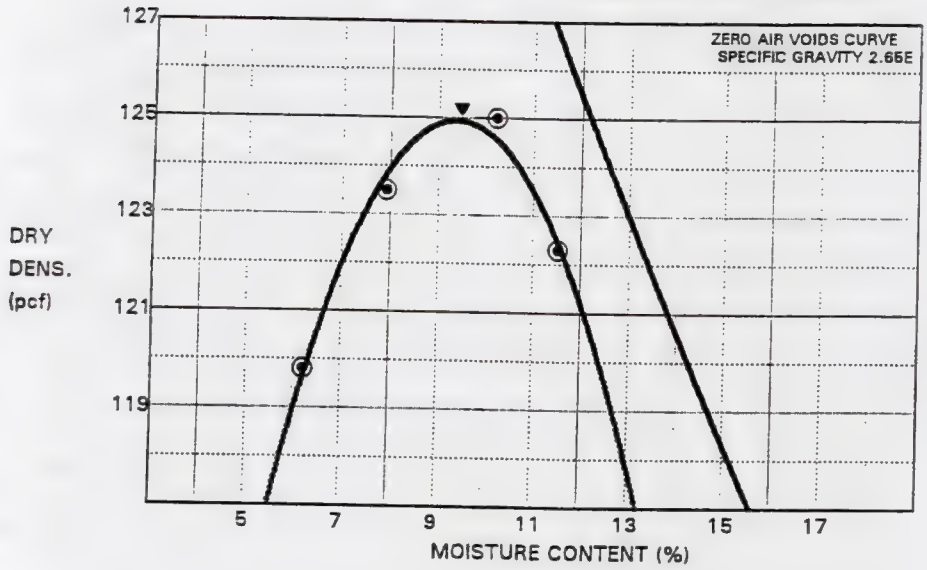
PROJECT DATA

CONTRACTOR: MAXIM TECHNOLOGIES, INC.
DATE SAMPLED: 1/28/98
SAMPLED BY: Todd Kuxhaus
TEST FOR: FILL
SAMPLE LOCATION: SB-C15-01; 1'-2'

Basin S-7

TEST DATE: 2/16/98
MATERIAL: NATIVE
CLASSIFICATION: SILTY SAND W/GRAVEL
MATERIAL PREPARATION METHOD: Moist
RAMMER TYPE: MANUAL
METHOD OF TEST: ASTM D2488
ASTM D698-A

REPORT OF TESTS



MAXIMUM DENSITY, PCF:	125.0
OPTIMUM MOISTURE (%):	9.5
% PASSING 3/4:	98.0
% PASSING 3/8:	94.0
% PASSING #4:	82.0
% PASSING #40:	33.0
% PASSING #200:	15.0

E = Estimated Value

Report Of Tests Continued On Page 2

1006

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MAXIM

DEPT. ENVIRONMENTAL QUALITY
PROJECT NO. 9731701
DATE OF SERVICE: 2/16/98

REPORT OF TESTS

ADDITIONAL COMMENTS:

SB-C15-01
1' - 2'
1/28/98
LAB NO. 2470-1

SIEVE ANALYSIS

Sieve Size	PERCENT PASSING
1"	100
3/4"	98
1/2"	96
3/8"	94
NO. 4	82
NO. 10	60
NO. 20	44
NO. 40	33
NO. 80	23
NO. 200	15

Technician: Steve Whitford
Engineering Technician

Report Distribution:
1) GARY FISCHER
1) TODD KUXHAUS

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser, P.E.
Engineering Manager

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Stream. 1

****
STABL4
****

ORIGINALLY CODED BY:
RONALD A. SIEGEL
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WEST LAYFAYETTE, INDIANA

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1

--Slope Stability Analysis--
Simplified Janbu Method of Slices
or Simplified Bishop Method

Stream. 1

PROBLEM DESCRIPTION STREAMSIDE TAILINGS UPSTREAM FACE SLOPE
STATIC
- 3:1 slope
- full pool, 2' freeboard
- phreatic line exits at downstream toe
- $\phi = 30°$ $\gamma_m = 110$ pcf
- F.S. = 2.1

BOUNDARY COORDINATES

6 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	20.00	20.00	20.00	1
2	20.00	20.00	41.00	27.00	1
3	41.00	27.00	48.00	29.00	1
4	48.00	29.00	54.00	29.00	1
5	54.00	29.00	69.00	20.00	1
6	69.00	20.00	89.00	20.00	1

1

ISOTROPIC SOIL PARAMETERS

Stream-1

1 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	125.0	.0	30.0	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	29.00
2	41.00	27.00
3	51.00	24.00
4	69.00	20.00
5	80.00	20.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 12.00 ft.
and X = 32.00 ft.

Each Surface Terminates Between X = 48.00 ft.
and X = 54.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

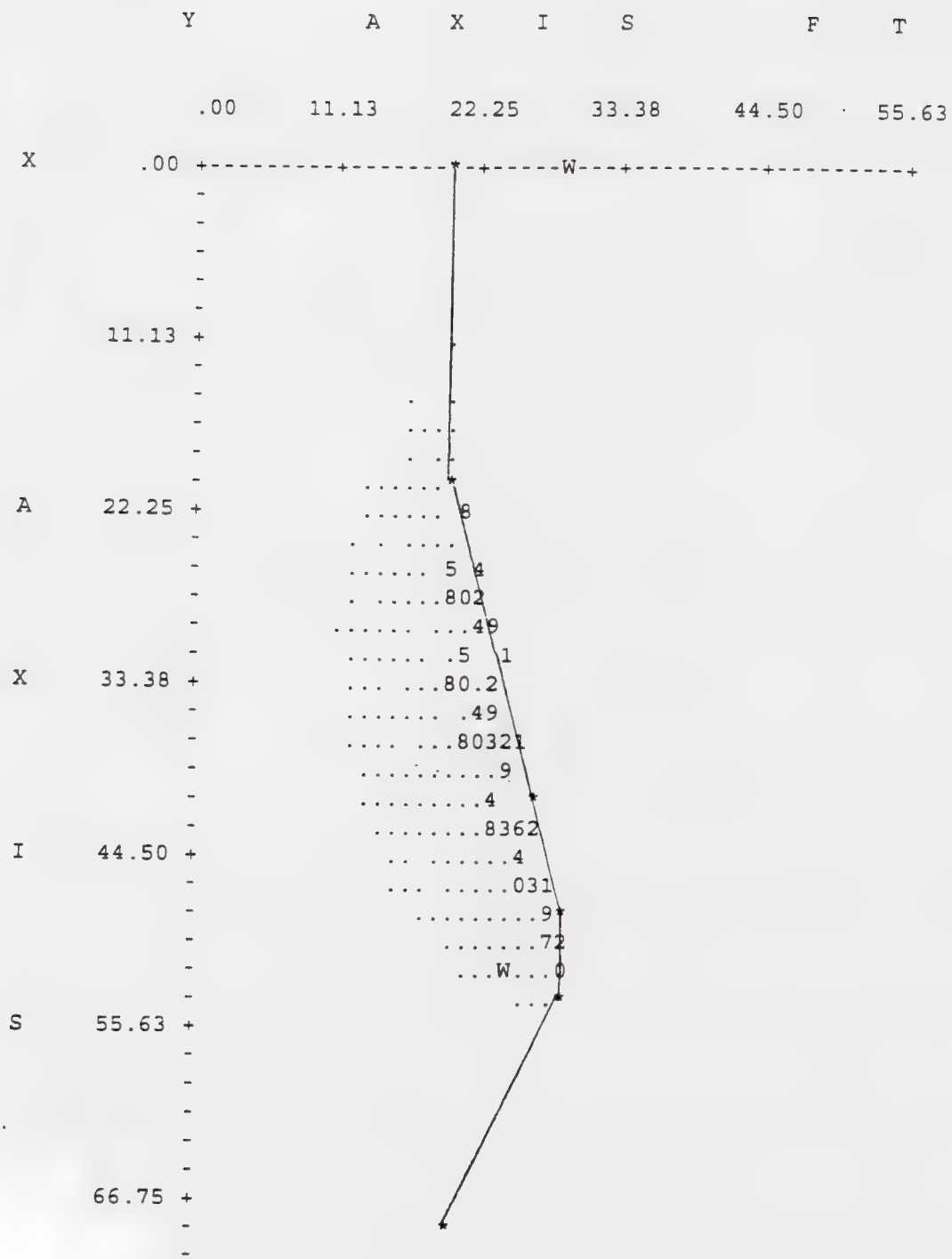
Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical

stream.1

1	23.11	21.04
2	28.11	20.84
3	33.09	21.26
4	37.98	22.29
5	42.71	23.92
6	47.20	26.13
7	51.38	28.87
8	51.53	29.00

*** 2.206 ***

1



Stream. 1

First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	32.00	24.00
2	36.87	25.12
3	41.69	26.46
4	46.44	28.02
5	49.02	29.00

*** 2.065 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	27.56	22.52
2	32.45	23.54
3	37.29	24.78
4	42.07	26.25
5	46.78	27.95
6	49.31	29.00

*** 2.069 ***

Failure Surface Specified By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	32.00	24.00
2	36.99	23.64
3	41.88	24.67
4	46.30	27.01
5	48.36	29.00

*** 2.074 ***

Failure Surface Specified By 7 Coordinate Points

Stream. 1

Point No.	X-Surf (ft)	Y-Surf (ft)
1	25.33	21.78
2	30.33	21.79
3	35.29	22.47
4	40.10	23.82
5	44.70	25.79
6	48.98	28.37
7	49.77	29.00

*** 2.103 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	20.89	20.30
2	25.89	20.43
3	30.85	21.06
4	35.72	22.19
5	40.45	23.80
6	45.00	25.88
7	49.31	28.41
8	50.13	29.00

*** 2.108 ***

Failure Surface Specified By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	32.00	24.00
2	37.00	24.16
3	41.90	25.14
4	46.58	26.91
5	50.16	29.00

*** 2.145 ***

1

Failure Surface Specified By 7 Coordinate Points

Stream. 1

Point No.	X-Surf (ft)	Y-Surf (ft)
1	25.33	21.78
2	30.33	21.82
3	35.29	22.46
4	40.13	23.71
5	44.79	25.54
6	49.18	27.92
7	50.71	29.00

*** 2.161 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.11	21.04
2	28.02	20.09
3	33.02	20.20
4	37.88	21.37
5	42.38	23.54
6	46.32	26.62
7	48.30	29.00

*** 2.165 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	29.78	23.26
2	34.77	23.61
3	39.68	24.53
4	44.45	26.03
5	49.02	28.07
6	50.58	29.00

*** 2.178 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

Stream . 2
2:1 slope
ϕ - 30°
γ_m = 110

****
STABL4
****

ORIGINALLY CODED BY:
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1

--Slope Stability Analysis--
Simplified Janbu Method of Slices
or Simplified Bishop Method

Stream. 2

PROBLEM DESCRIPTION STREAMSIDE TAILINGS DOWNSTREAM FACE SLOP
E STATIC

- 2:1 slope
- full pool, 2' freeboard
- ϕ = 30° γ_m = 110 pcf
- phreatic surface exits at downstream toe.
- F.S. = 1.0
- very shallow infinite slope failure

BOUNDARY COORDINATES

6 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	20.00	11.00	20.00	1
2	11.00	20.00	26.00	29.00	1
3	26.00	29.00	32.00	29.00	1
4	32.00	29.00	39.00	27.00	1
5	39.00	27.00	60.00	20.00	1
6	60.00	20.00	80.00	20.00	1

1

ISOTROPIC SOIL PARAMETERS

Stream. 2

1 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	125.0	.0	30.0	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	20.00
2	11.00	20.00
3	29.00	24.00
4	39.00	27.00
5	80.00	27.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 6.00 ft.
and X = 18.00 ft.

Each Surface Terminates Between X = 26.00 ft.
and X = 32.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical

Stream.2

First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	11.33	20.20
2	15.92	22.19
3	20.27	24.65
4	24.35	27.55
5	26.00	29.00

*** .973 ***

Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	14.00	21.80
2	18.52	23.94
3	22.86	26.42
4	26.69	29.00

*** .994 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.00	20.00
2	10.92	19.11
3	15.89	19.69
4	20.46	21.70
5	24.25	24.97
6	26.78	29.00

*** 1.004 ***

Failure Surface Specified By 7 Coordinate Points

Stream.2

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.00	20.00
2	10.94	19.21
3	15.91	19.76
4	20.56	21.60
5	24.56	24.60
6	27.62	28.55
7	27.80	29.00

*** 1.028 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.67	20.00
2	13.59	19.13
3	18.53	19.89
4	22.98	22.18
5	26.45	25.78
6	27.98	29.00

*** 1.039 ***

Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	18.00	24.20
2	22.66	26.00
3	26.76	28.88
4	26.86	29.00

*** 1.040 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.67	20.00

Stream. 2

2	13.44	18.52
3	18.43	18.92
4	22.91	21.14
5	26.26	24.85
6	27.79	29.00

*** 1.051 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.00	20.00
2	10.80	18.61
3	15.80	18.67
4	20.58	20.16
5	24.72	22.97
6	27.87	26.84
7	28.76	29.00

*** 1.057 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.67	20.00
2	13.42	18.44
3	18.41	18.75
4	22.93	20.88
5	26.35	24.53
6	28.12	29.00

*** 1.061 ***

Failure Surface Specified By 6 Coordinate Points

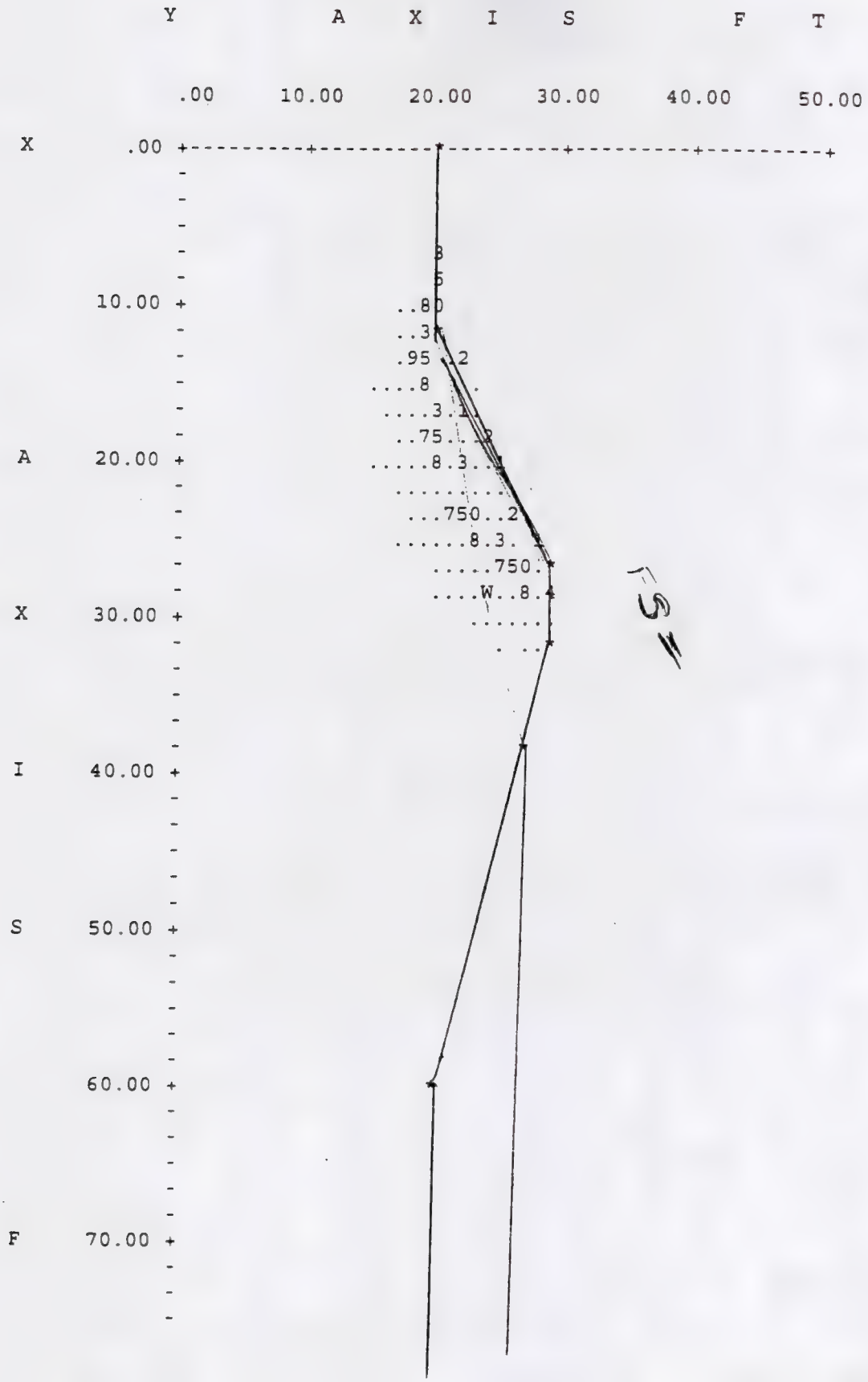
Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.00	20.00
2	14.83	18.71
3	19.74	19.65
4	23.77	22.62
5	26.10	27.04

Stream. 2

6 26.18 29.00

*** 1.064 ***

1



Stream. 3

****
STABL4
****

ORIGINALLY CODED BY:
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1

--Slope Stability Analysis--
Simplified Janbu Method of Slices
or Simplified Bishop Method

Stream. 3

PROBLEM DESCRIPTION STREAMSIDE TAILINGS DOWNSTREAM FACE SLOP
E STATIC

- 2:1 slope
- full pool, 2' freeboard
- pheatic surface exits at downstream to
- $\phi = 32°$ $\gamma = 100$pcf
- F.S. = 1.1
- same as Stream. 2 except lower strength properties - still unstable

BOUNDARY COORDINATES

6 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	20.00	11.00	20.00	1
2	11.00	20.00	26.00	29.00	1
3	26.00	29.00	32.00	29.00	1
4	32.00	29.00	39.00	27.00	1
5	39.00	27.00	60.00	20.00	1
6	60.00	20.00	80.00	20.00	1

ISOTROPIC SOIL PARAMETERS

Stream. 3

1 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	100.0	125.0	.0	32.0	.00	.0	1

1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 5 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	20.00
2	11.00	20.00
3	29.00	24.00
4	39.00	27.00
5	80.00	27.00

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 6.00 ft.
and X = 18.00 ft.

Each Surface Terminates Between X = 26.00 ft.
and X = 32.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical

Stream. 5

First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	11.33	20.20
2	15.92	22.19
3	20.27	24.65
4	24.35	27.55
5	26.00	29.00

*** 1.053 ***

Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	14.00	21.80
2	18.52	23.94
3	22.86	26.42
4	26.69	29.00

*** 1.075 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.00	20.00
2	10.92	19.11
3	15.89	19.69
4	20.46	21.70
5	24.25	24.97
6	26.78	29.00

*** 1.095 ***

Failure Surface Specified By 7 Coordinate Points

Stream. 3

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.00	20.00
2	10.94	19.21
3	15.91	19.76
4	20.56	21.60
5	24.56	24.60
6	27.62	28.55
7	27.80	29.00

*** 1.119 ***

1

Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	18.00	24.20
2	22.66	26.00
3	26.76	28.88
4	26.86	29.00

*** 1.125 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.67	20.00
2	13.59	19.13
3	18.53	19.89
4	22.98	22.18
5	26.45	25.78
6	27.98	29.00

*** 1.129 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.67	20.00

Stream. 3

2	13.44	18.52
3	18.43	18.92
4	22.91	21.14
5	26.26	24.85
6	27.79	29.00

*** 1.145 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.00	20.00
2	10.80	18.61
3	15.80	18.67
4	20.58	20.16
5	24.72	22.97
6	27.87	26.84
7	28.76	29.00

*** 1.154 ***

1

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.67	20.00
2	13.42	18.44
3	18.41	18.75
4	22.93	20.88
5	26.35	24.53
6	28.12	29.00

*** 1.156 ***

Failure Surface Specified By 6 Coordinate Points

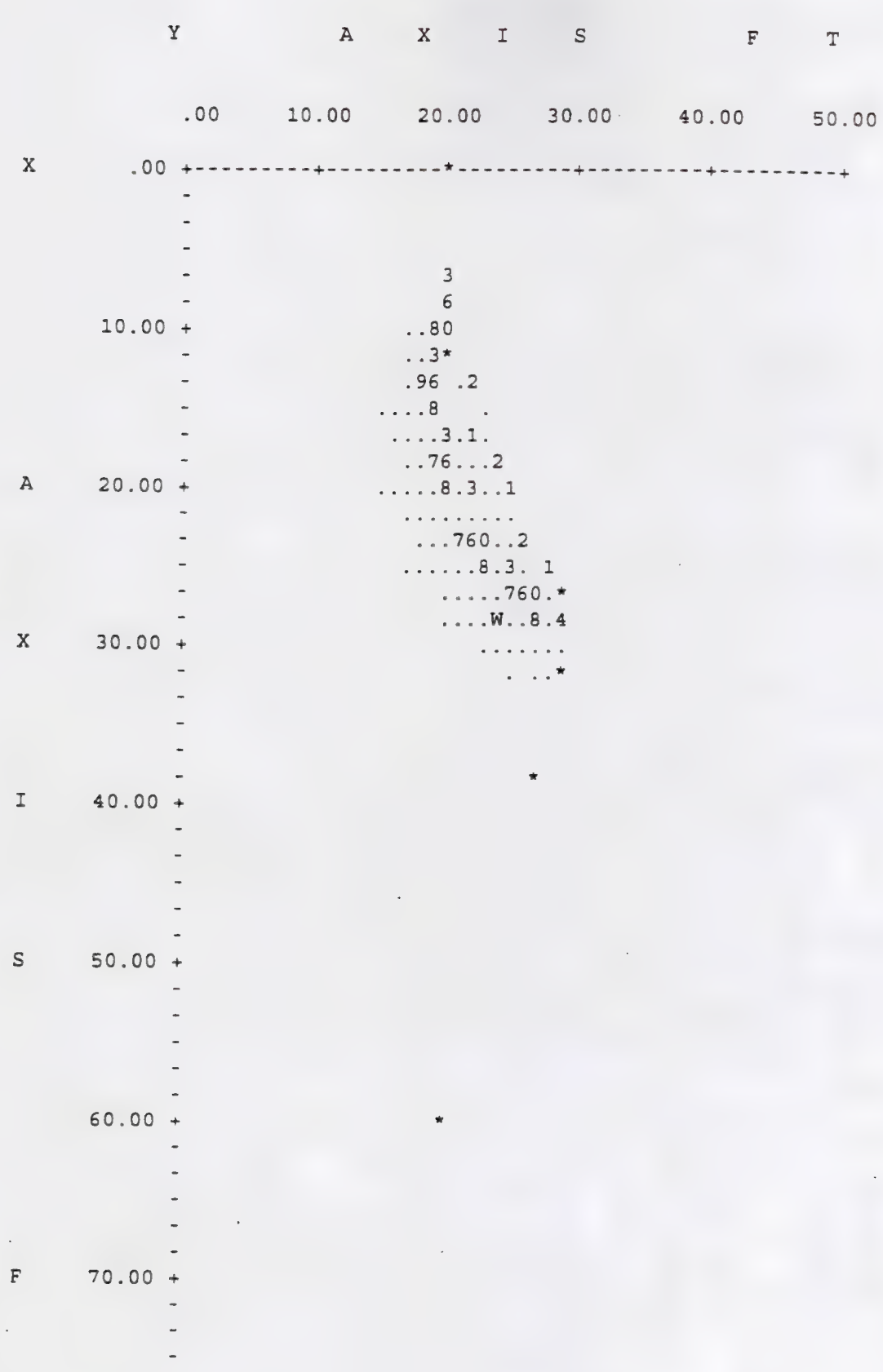
Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.00	20.00
2	14.83	18.71
3	19.74	19.65
4	23.77	22.62
5	26.10	27.04

Stream. 3

6 26.18 29.00

*** 1.159 ***

1



Stream, 4
3:1 symetric slopes
FS = 1.5
ϕ = 32 γ_m = 100 p.c.f

****
****** EXECUTION OF STABL ABORTED ******
****

****
STABL4
****

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1

--Slope Stability Analysis--
Simplified Janbu Method of Slices
or Simplified Bishop Method

Stream, 4

PROBLEM DESCRIPTION STREAMSIDE TAILINGS DOWNSTREAM FACE SLOP
E STATIC
- downstream slope flattened to 3:1
- full pool, 2' freeboard
- phreatic surface exits embankment face 2' above toe.
- ϕ = 32° γ_m = 100pcf
- F.S. = 1.5 - stable.

BOUNDARY COORDINATES

6 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	20.00	10.00	20.00	1
2	10.00	20.00	37.00	29.00	1
3	37.00	29.00	43.00	29.00	1
4	43.00	29.00	50.00	27.00	1
5	50.00	27.00	71.00	20.00	1
6	71.00	20.00	90.00	20.00	1

Stream. 4

ISOTROPIC SOIL PARAMETERS

1 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	100.0	125.0	.0	32.0	.00	.0	1

1 PIEZOMETRIC SURFACE(S) HAVE BEEN SPECIFIED

Unit Weight of Water = 62.40

Piezometric Surface No. 1 Specified by 6 Coordinate Points

Point No.	X-Water (ft)	Y-Water (ft)
1	.00	20.00
2	10.00	20.00
3	16.00	22.00
4	40.00	24.00
5	50.00	27.00
6	90.00	27.00

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 6.00 ft.
and X = 24.00 ft.

Each Surface Terminates Between X = 37.00 ft.
and X = 43.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

5.00 ft. Line Segments Define Each Trial Failure Surface.

Stream 4

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.00	20.00
2	12.91	19.03
3	17.90	18.92
4	22.84	19.69
5	27.58	21.30
6	31.96	23.72
7	35.85	26.85
8	37.72	29.00

*** 1.527 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.00	20.00
2	10.93	19.15
3	15.93	19.01
4	20.89	19.59
5	25.73	20.86
6	30.34	22.80
7	34.62	25.38
8	38.49	28.54
9	38.92	29.00

*** 1.562 ***

1

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.00	20.00

Stream. 4

2	10.76	18.46
3	15.71	17.76
4	20.70	17.93
5	25.60	18.97
6	30.24	20.83
7	34.48	23.47
8	38.21	26.81
9	39.93	29.00

*** 1.582 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.00	20.00
2	10.78	18.53
3	15.74	17.88
4	20.73	18.07
5	25.63	19.10
6	30.28	20.93
7	34.56	23.51
8	38.35	26.78
9	40.18	29.00

*** 1.590 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.00	20.00
2	14.70	18.28
3	19.66	17.69
4	24.63	18.25
5	29.34	19.93
6	33.54	22.64
7	37.00	26.25
8	38.63	29.00

*** 1.601 ***

Failure Surface Specified By 8 Coordinate Points

Point	X-Surf	Y-Surf

Stream .4

No.	(ft)	(ft)
1	10.00	20.00
2	14.69	18.26
3	19.65	17.64
4	24.62	18.16
5	29.35	19.79
6	33.57	22.46
7	37.08	26.03
8	38.90	29.00

*** 1.610 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.00	20.00
2	14.65	18.16
3	19.59	17.39
4	24.58	17.73
5	29.37	19.17
6	33.72	21.63
7	37.42	24.99
8	40.23	29.00

*** 1.655 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.00	20.00
2	10.32	17.49
3	15.09	15.96
4	20.06	15.50
5	25.03	16.12
6	29.74	17.79
7	33.98	20.44
8	37.55	23.94
9	40.29	28.12
10	40.62	29.00

*** 1.664 ***

Stream. 4

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	12.00	20.67
2	16.92	19.76
3	21.92	19.83
4	26.81	20.86
5	31.41	22.81
6	35.55	25.62
7	38.88	29.00

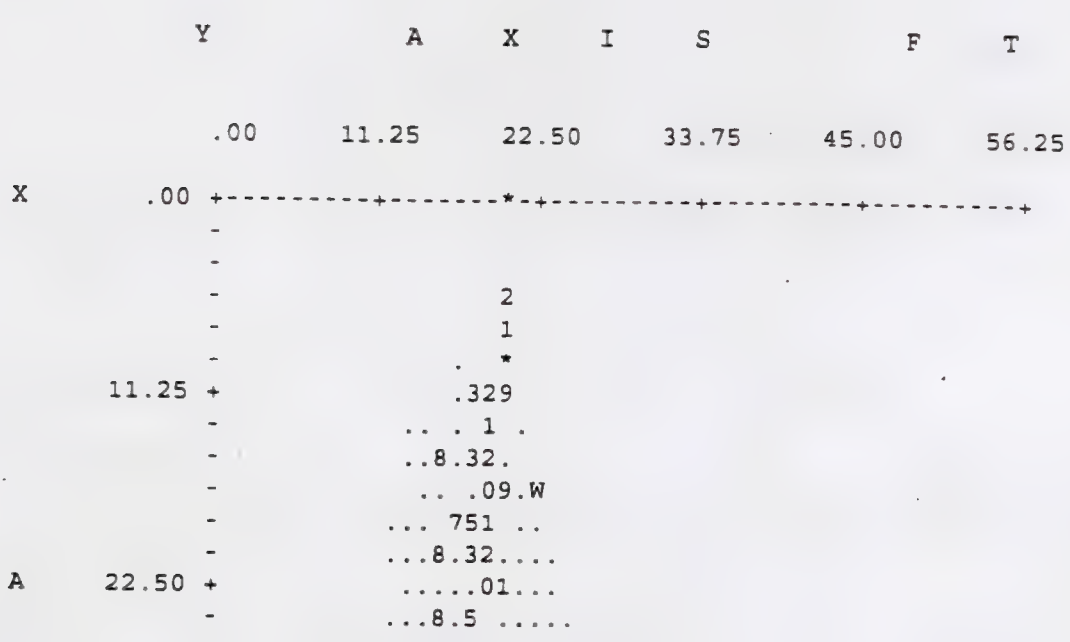
*** 1.666 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	12.00	20.67
2	16.79	19.24
3	21.78	18.94
4	26.72	19.76
5	31.34	21.67
6	35.41	24.57
7	38.73	28.31
8	39.10	29.00

*** 1.679 ***

1



MAXIM TECHNOLOGIES INC

BY G. FISCHER DATE 2/6/98

JOB TITLE SST - RR Materials JOB NUMBER 9731701-190

SUBJECT Sediment Basins - Outlet/Spillways SHEET 1 of 6

SEDIMENT BASIN OUTLET DESIGN

- OUTLET IS A PIPE DROP STRUCTURE
- PIPE SIZE IS 12" DIA HDPE
- MAX FLOWS FOR SMALLER BASINS = 1.21 CFS
  (BASINS FOR AREAS C15, C14, C7-C10, C5.5)
  S-7 S-6 S-4 S-3
- OUTLET IS MODELED AS A WEIR. (REF: DESIGN OF SMALL DAMS, USBR, p. 417)

$$Q = CLH^{3/2}$$

L = LENGTH = $2\pi R$ $R = 0.5$ FT

$L = 2\pi(0.5) = 3.14$ FT

H = HEAD ABOVE WEIR = 1.0 FT

C = WEIR COEFFICIENT

FROM FIG 283 OF REF, (SEE SHT 2A)

$\frac{H}{R} = \frac{1.0}{0.5} = 2.0$ $\therefore C = 4.0$

$Q = 4.0(3.14)(1)^{3/2} = \underline{12.56 \text{ CFS}} > 1.21$ OK

∴ USE 12" DIA PIPE ON SMALLER BASINS

MAXIM TECHNOLOGIES INC

BY GEF DATE 2/6/98

JOB TITLE SST - RR Mat'ls JOB NUMBER

SUBJECT Sed Basins - Outlets SHEET 2 of 6

- MAX FLOW FOR LARGER BASINS = 8 CFS
  (BASINS FOR AREAS C5-C6 & C1/C2-C4 COMBINED (S-2)
  C11-C13 (S-5), AND WHISKEY GULCH (S-1))

TRY A 12" PIPE WITH H = 2 FT: C = 1.0

$Q = (1.0)(3.14)(2)^{3/2} =$ 8.9 CFS > 8 OK

OR TRY A 24" PIPE WITH H = 1 FT:

$Q = (2.05)(2)(\pi)(1.0)(1)^{3/2}$ C = 2.05

= 12.9 CFS > 8 OK

OR TRY AN 18" PIPE WITH H = 1 FT: C = 1.55

$Q = (1.55)(2)(\pi)(0.75)(1)^{3/2} =$ 7.3 CFS

THIS CANNOT BE USED ON WHISKEY GULCH, BUT CAN BE USED ON THE OTHER 2 LARGER BASINS. (S-2 and S-5)

(S-1)

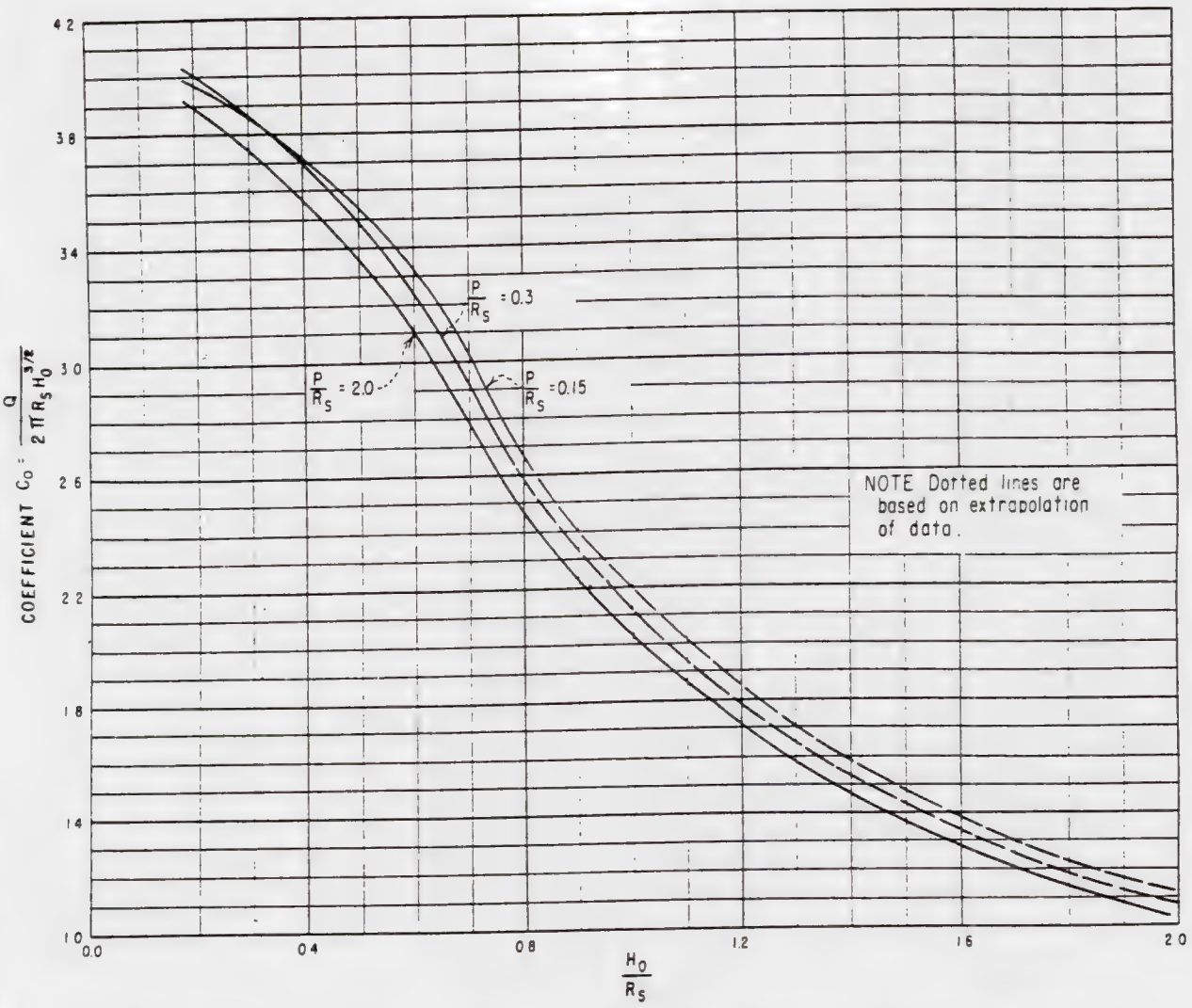


Figure 283. Relationship of circular crest coefficient C_o to $\frac{H_e}{R_s}$ for different approach depths (aerated nappe). 288–D–2441.

The profiles become increasingly suppressed for larger $\frac{H_e}{R_s}$ values. Below the high point of the profile the traces cross and the shapes for the higher heads fall inside those for the lower heads. Thus, if the crest profile is designed for heads where $\frac{H_e}{R_s}$ exceeds about 0.25 to 0.3, it appears that subatmospheric pressure will occur along some portion of the profile when heads are less than the designed maximum. If subatmospheric pressures are to be avoided along the crest profile, the crest shape should be selected so that it will give support to the overflow nappe for the smaller $\frac{H_e}{R_s}$ ratios. Figure 288 shows the approximate increase in radius required to minimize subatmospheric pressures on the crest. The crest shape for the enlarged crest radius is then based on a $\frac{H'_e}{R'_s}$ ratio of 0.3.

(d) *Transition Design.*—The diameter of a jet issuing from a horizontal orifice can be determined for any point below the water surface if it is assumed that the continuity equation, $Q=av$, is valid and if friction and other losses are neglected.

MAXIM TECHNOLOGIES INC

BY GRF DATE 2/6/98

JOB TITLE CST - RR Mat'ls JOB NUMBER

SUBJECT Sed Basins - Spillways SHEET 3 of 6

SPILLWAYS

- TWO CONFIGUERATIONS:

(1) 10' WIDE, SS = 2:1, 1 FT DEEP, 0.01 SLOPE

(2) 10' WIDE, SS = 2:1, 2 FT DEEP, 0.01 SLOPE

10 FT SPILLWAY CAPACITY (1' deep)

$$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$$

$n = 0.04$ (riprap)

$$A = \frac{(10+14)}{2} \times 1 = 12 \text{ FT}^2$$

$$R = \frac{A}{P} = \frac{12}{10+2(2.2)}$$

$$= 0.83 \text{ FT}$$

$S = 0.01$

$$Q = \frac{1.49}{0.04}(12)(0.83)^{2/3}(.01)^{1/2}$$

$Q = 39$ CFS

Avg V = $39/12 = 3.25$ fps

10 FT SPILLWAY CAPACITY (2' Deep)

$$A = \left(\frac{10+18}{2}\right) \times 2 = 28 \text{ ft}^2$$

$$R = \frac{28}{10+2(2.2)} = 1.94 \text{ FT}$$

$$Q = \frac{1.49}{0.04}(28)(1.94)^{2/3}(.01)^{1/2} = 163 \text{ CFS}$$

Avg V = $163/28 = 5.82$ fps.

MAXIM TECHNOLOGIES INC

BY GRF DATE 2/6/98

JOB TITLE SST - RR Mat'ls JOB NUMBER

SUBJECT Sed Basins - Spillways SHEET 4 of 6

CONTROL FLOW FOR 10' SPILLWAY (1' deep)

- ESTIMATE SPILLWAY ACTS AS A BROAD-CRESTED WEIR
- CONSERVATIVE ESTIMATE OF C IS 2.5

$Q = CLH^{3/2}$ $L = 10$ FT, $H = 1$ FT

$Q = 2.5(10)(1)^{3/2} = 25$ CFS

CONTROL FLOW OVER 10' SPILLWAY (2' deep)

$Q = 2.5(10)(2)^{3/2} = 70$ CFS

RELIABILITY OF SPILLWAYS

TO ESTIMATE THE RELIABILITY, OR RECURRENCE INTERVAL, OF THE SPILLWAYS, A COMPARISON TO SMALL CREEKS IN THE AREA WILL BE MADE

REF: USGS Water-Resources Investigations Report 92-4048, Analysis of the Magnitude and Frequency of Floods and the Peak Flow Gaging Network in Montana.

MAXIM TECHNOLOGIES INC

BY GRF DATE 2/6/98

JOB TITLE SST - RR Mat'ls JOB NUMBER

SUBJECT Sed Basins - Spillways SHEET 5 of 6

Station	Q_{10}	$\frac{Q_{10}}{Q_{10}}$	Q_{50}	$\frac{Q_{50}}{Q_{10}}$	Q_{100}	$\frac{Q_{100}}{Q_{10}}$	Q_{500}	$\frac{Q_{500}}{Q_{10}}$
Smith Gulch near Silver Bow	68	1.0	140	2.1	179	2.6	289	4.3
German Gulch near Ramsay	357	1.0	531	1.5	612	1.7	815	2.3

FOR SMALL BASINS, $Q_{10\,max} = 1.21$ CFS

CONSERVATIVE $Q_{500\,max} = 1.21 \times 4.3 = 5.2$ CFS

5.2 CFS < 25 CFS SPILLWAY

FOR LARGER BASINS, $Q_{10\,max} = 8$ CFS

CONSERVATIVE $Q_{500\,max} = 8 \times 4.3 = 34.4$ CFS

34.4 CFS < 70 CFS SPILLWAY

∴ THE SPILLWAYS OFFER GREATER THAN 500-YEAR PROTECTION.

MAXIM TECHNOLOGIES INC

BY GRF DATE 2/13/98

JOB TITLE SST - RR Matls JOB NUMBER

SUBJECT Sed Basins - Spillways SHEET 6 of 6

CHECK ON RIPRAP SIZE

Riprap size reference:

FWHA - IP-89-016 March 1989
Hydraulic Engineering Circular No. 11

From Maxim (Fischer) Calcs for streamside riprap dated 12/19/97:

$$D_{50} = 0.0025\ V_a^3 / d_{avg}^{0.5}$$

For 1' deep channel, $d_{avg} = 1$ ft

$V_a = 3.25$ fps

$$D_{50} = 0.0025\ (3.25)^3 / (1)^{0.5} = 0.08 \text{ ft}$$

For 2' Deep channel, $d_{avg} = 2$ ft

$V_a = 5.82$ fps

$$D_{50} = 0.0025\ (5.82)^3 / (2)^{0.5} = 0.34 \text{ ft}$$

For both cases D_{50} of 6" is adequate.

APPENDIX K-2

Field Verification of Contaminated Material Locations and Properties

FIELD VERIFICATION RESULTS
RAILROAD MATERIALS INVESTIGATION
Streamside Tailings Operable Unit Remedial Design

1.0 PURPOSE AND OBJECTIVES

The purpose of the railroad materials investigation was to verify the location, extent, and physical and chemical properties of mine waste materials present in railroad embankments. The results of this investigation will be used to support the conceptual designs that will be considered to remediate railroad waste materials.

Railroad waste materials present in the embankments fall into three categories that might require different approaches to remediation. These categories are:

- Mine waste materials present along the streambanks of Silver Bow Creek that would be in direct contact with the stream.

- Mine waste materials that are present in areas that would contribute runoff to the remediated floodplain.

- Ore concentrate materials that are present in the railroad bed or embankment as a result of past spills.

During the Remedial Investigation (RI), railroad bed materials were mapped and sampled and the samples submitted to an analytical laboratory for analysis of total metal concentrations. Mapping indicated that there were approximately 23 areas on the three rail lines present in Subarea 1 of the operable unit that contained mine waste materials. Chemical analysis indicated that these materials had elevated contaminant concentrations. Volume estimates were also calculated based on average height and cross-sectional area estimates. Using this data as a guide, the objectives of the remedial design investigation were:

- Verify the location of waste materials present in the railroad bed in those locations identified in the RI. Visual identification, field staking, and surveying are the methods used to fulfill this objective.

- Verify the contaminant concentrations by sampling at selected locations and analyzing the wastes for total arsenic and metals.

- Collect samples for other physical and chemical parameters needed for the remedial design.

The railroad materials field investigation was conducted according to the methods and procedures outlined in the *Comprehensive Remedial Design Sampling and Analysis Plan* (ARCO, October 1996) and the *Sampling and Analysis Plan Addendum* (Maxim Technologies, September 1997) for railroad materials. The following sections briefly summarize the methods and procedures outlined in these two plans and present the engineering and chemical analytical results.

2.0 METHODS AND PROCEDURES

The field investigation for this effort is comprised of two parts: (1) verifying the location of contaminated materials on or within railroad embankments by field staking; and, (2) collecting samples from contaminated waste materials in specific locations.

2.1 FIELD OBSERVATIONS AND STAKING

The extent of waste materials at locations identified in the RI were field verified by visually examining shallow (generally less than two to three feet) hand-dug observation pits. Visual verification of waste materials was generally based on color and composition of the embankment material. The limits of each waste material area were staked with survey lath and labeled according to the letter and number designation provided on Plates 1a through 1e of the RI. Survey lath was staked along the toe of the railroad embankments at the west and east ends of each waste material area.

The limits of the waste embankment areas were surveyed using a Global Positioning System (GPS). The direction of surface water drainage from each waste embankment area was also plotted on the field maps to indicate the areas that could potentially be impacted with contaminated runoff. The location of culverts and other drainage features that flow onto the Silver Bow Creek floodplain were also verified and plotted on the maps at all locations that were reasonably expected to receive drainage from a waste embankment area.

2.2 WASTE MATERIAL SAMPLING

Railroad waste material samples were collected from visually identified ore concentrate spill areas, waste embankment areas, and railroad bridge abutments. Figures B-1 through B-4 in the main body of the report show the sample locations.

2.2.1 Sample Locations

Samples collected for this investigation are listed below. The first two letters (VR) indicate the sample was collected for this investigation. This part of the identifier is not used further in this report but is shown on the laboratory reports. The next letter following the hyphen indicates the railroad line where the sample was collected (B = Butte Anaconda and Pacific; C = Chicago Milwaukee and St. Paul; U = Union Pacific). For concentrate spills, the letter C follows the railroad line identifier. The sample identification number corresponds with the numbers assigned to the waste areas for the RI mapping which were originally presented on Plates 1a through 1e in the RI Report.

- Concentrate Spill Areas — BC1, BC2, BC3, CC1
- Railroad Embankment Areas — B10, B13, B23, B27, C19.6, C20, U5
- Railroad Bridge Abutment areas — B15, B26, C18, C19, U5.5

Concentrate spill area CC1 was not previously identified during the RI. This concentrate spill is located near the Neversweat railroad spur in Rocker. Also, C19.6 and U5.5 were not originally identified during the RI, therefore these are new identifiers for the corresponding waste material locations. This method

of providing new identifiers was used for other locations found during field verification and are indicated on the maps presented in the text of this report.

2.2.2 Sampling Methods, Procedures, and Analysis

Sample test pits were dug with a shovel. Ore concentrate spill areas were excavated to the full depth of visually observed concentrate material which in all cases was two feet. After excavation of each sample pit, the general lithology of the sample pit sidewall was logged in the field book by noting soil material type, depth, and grain size. Depth of sampling and analytical testing for each of the waste material types are described below.

- *Ore concentrate spill areas* were sampled for XRF total metals (As, Cd, Cu, Pb, and Zn). The concentrate spill samples were collected in depth increments of six inches. A deviation from the Comprehensive SAP was the elimination of pH as an analytical parameter.

- *Railroad bridge abutment sites*, were located at the railroad crossings over Silver Bow Creek above and below the Rocker Siding. Samples were collected from each of the abutments containing waste materials. Subsamples were collected from the west and east abutment on each rail line and composited. Samples were analyzed for pH, Acid Base Account, and SMP Lime Requirement.

- *Waste embankment areas* were sampled in the 0 to 2-inch interval. Each sample consisted of composites of five subsample locations which were spaced approximately 50 feet apart near the middle of each waste embankment area. The central subsample represents the staked sample location. Samples were analyzed for XRF total metals. At three of the waste embankment areas, samples were collected for sieve analysis.

3.0 ANALYTICAL RESULTS

Analytical results of railroad material sampling are presented in this section. The data shown in Tables A-1 and A-2 summarize the chemical analytical data. Engineering properties (sieve analysis) and laboratory analytical reports are contained in Attachment A.

TABLE A-1
XRF Total Metals Concentrations
Ore Concentrate Spill Areas and Waste Embankments
Railroad Materials Investigation

Sample Type	Sample No.	Depth (inches)	Arsenic (mg/Kg)	Cadmium (mg/Kg)	Copper (mg/Kg)	Lead (mg/Kg)	Zinc (mg/Kg)
Concentrate	BC1	0-6	9,030	5	51,500	1,100	838
	BC1	6-12	215	7	5,440	259	1,760
	BC1	12-18	1,100	14	10,700	680	6,160
	BC1	18-24	2,840	32	8,760	1,250	16,300
Concentrate	BC2	0-6	6,440	8	20,900	2,420	2,730
	BC2	6-12	1,930	5	2,680	1,570	682
	BC2	12-18	568	5	1,360	154	281
	BC2	18-24	78	5	1,400	43	295
Concentrate	BC3	0-6	6,370	5	44,600	4,720	1,740
	BC3	6-12	2,780	8	6,560	2,060	3,600
	BC3	12-18	1,920	6	5,850	1,940	2,320
	BC3	18-24	374	5	2,460	149	618
Concentrate	CC1	0-6	2,950	14	38,500	1,970	4,610
	CC1	6-12	3,180	16	61,100	2,290	3,740
	CC1	12-18	282	8	16,400	324	1,460
	CC1	18-24	44	5	2,530	61	879
Embankment	U5	0-2	418	5	2,170	411	729
	B10	0-2	462	5	807	221	133
	B13	0-2	317	5	1,260	1,780	502
	B23	0-2	896	8	1,340	4,170	4,420
	B27	0-2	1,160	6	2,270	785	2,920
	C19.6	0-2	655	5	1,440	332	1,800
	C20	0-2	1,530	5	1,400	450	479

Notes: mg/Kg = milligrams per kilogram

TABLE A-2
Acid Base Accounting
Railroad Abutments and Embankments
Railroad Materials Investigation

Sample Type	Sample No.	Sample Depth	pH (s.u.)	Neutralization Potential (t/1000t)	Acid Potential (t/1000t)	SMP Lime Requirement (t/1000t)	Total Lime Requirement (t/1000 tons)
Abutment	B15	0-24	4.5	< 1	6	9	19
	C18	0-24	4.0	<1	81	11	115
	C19	0-24	4.0	<1	16	12	35
	B26	0-24	3.1	<1	220	17	296
	U5.5	0-24	5.2	<1	12	5	21
Embankment	C19.6	0-2	3.8	<1	77	12	111

Notes: s.u. = standard units; t/1000t = tons per thousand tons
Total Lime Requirement calculated according to the following formula: [(HNO3 Sulfur + Residual Sulfur)*31.25 + (HCL Sulfur)*23.44+SNP]*1.25

MAXIM TECHNOLOGIES INC

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REPORT OF SIEVE ANALYSIS

CLIENT: BILL BUCHER
MAXIM TECHNOLOGIES, INC.
P.O. BOX 4699
HELENA, MT 59604-4699

PROJECT: STREAM SIDE TAILINGS

PROJECT NO.: 5609702728
REPORT NO.: 1939
DATE OF SERVICE: 9/25/97
AUTHORIZATION: MAXIM TECHNOLOGIES
REPORT DATE: 9/25/97

SERVICES: Perform sieve analysis tests on samples delivered to our laboratory in accordance with ASTM C136 and C117.

REPORT OF TESTS

	EMBANKMENT: VR B13 4" to NO. 200 9/18/97 LAB NO. 1939-1	ABUTMENT: VR B15 EAST, VRC-18 3" to NO. 200 9/18/97 LAB NO. 1939-2
SIEVE ANALYSIS Sieve Size	PERCENT PASSING	
4"	100	
3"	91	100
2"	83	86
1 1/2"	76	85
1"	70	83
3/4"	66	81
1/2"	61	78
3/8"	58	75
NO. 4	50	69
NO. 10	40	59
NO. 20	31	43
NO. 40	25	32
NO. 80	18	20
NO. 200	13	12

Report Of Tests Continued On Page 2

1099 J

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Attachment A-1

MAXIM

BILL BUCHER
PROJECT NO. 5609702728
DATE OF SERVICE: 9/25/97

REPORT NO. 1939
PAGE 2 OF 3

REPORT OF TESTS (Continued)

SIEVE ANALYSIS Sieve Size	ABUTMENT: VR-B-26, VR-C19 3" to NO. 200 9/18/97 LAB NO. 1939-3 PERCENT PASSING	EMBANKMENT: VR-B-10 4" to NO. 200 9/19/97 LAB NO. 1939-4 PERCENT PASSING
4"		100
3"	100	92
2"	86	90
1 1/2"	79	86
1"	72	77
3/4"	66	72
1/2"	59	64
3/8"	55	59
NO. 4	49	48
NO. 10	40	38
NO. 20	30	28
NO. 40	23	22
NO. 80	15	15
NO. 200	11	10

Report Of Tests Continued On Page 3

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Attachment A-2

MAXIM

BILL BUCHER
PROJECT NO. 5609702728
DATE OF SERVICE: 9/25/97

REPORT NO. 1939
PAGE 3 OF 3

REPORT OF TESTS (Continued)

EMBANKMENT
VRC-19.6
5" to NO. 200
9/19/97
LAB NO. 1939-5

SIEVE ANALYSIS Sieve Size	PERCENT PASSING
5"	100
4"	86
3"	86
2"	78
1 1/2"	70
1"	61
3/4"	56
1/2"	51
3/8"	47
NO. 4	39
NO. 10	32
NO. 20	22
NO. 40	15
NO. 80	9
NO. 200	6.4

Technician:

Report Distribution:
"1) BILL BUCHER

MAXIM TECHNOLOGIES INC.

Jeremiah B. Bowser

Jeremiah B. Bowser, P.E.
Engineering Manager

1089 J

Our letters and reports are for the exclusive use of the client to whom they are addressed and shall not be reproduced except in full without the approval of the testing laboratory. The use of our name must receive our written approval. Our letters and reports apply only to the sample tested and/or inspected, and are not indicative of the quantities of apparently identical or similar products.

Attachment A - 3

Maxim
600 South 25th Street
P O Box 30615
Billings, MT 59107
(406) 248-9161
FAX (406) 248-9282

TECHNICAL REPORT

REPORT TO: ATTN: MIKE CORMIER
MAXIM TECHNOLOGIES, INC.
P O BOX 4699
HELENA MT 59604

DATE: October 17, 1997
JOB NUMBER: 87-911
SHEET: 1 of 10
INVOICE NO.: G0325

REPORT OF: Soil Analysis - Streamside Tailings - Railroad Materials - 5609702728.07

SAMPLE IDENTIFICATION:

On September 23, 1997, these soil samples (laboratory numbers 187586 through 187592) were received in our laboratory for analysis. The tests were conducted in accordance with EPA/600/2-78-054 *"Field and Laboratory Methods Applicable to Overburden and Mine Soils"* and *"Western States Laboratory Proficiency Testing Program, Soil and Plant Analytical Methods"*.

The condition of the samples upon receipt at the laboratory is noted on the attached sample receipt checklist. Chain of custody documentation is enclosed.

The test results are shown on the following pages.

A < sign indicates the value reported was the practical quantitation limit for this sample using the method described. Concentrations of analyte, if present, below this were not quantifiable.

The formulas used to calculate the Acid Potential are as follows:

Acid Potential = $(HNO_3\text{-}S + Residual\text{-}S)31.25 + (HCl\text{-}S)\ 23.44$

Reviewed by Kathleen A. H.

Attachments: Chain of Custody
Sample Receipt Checklist

RECEIVED
NOV 21 1997
MAXIM TECHNOLOGIES
HELENA, MT

caj

As a mutual protection to clients, the public and ourselves, all reports are submitted as the confidential property of client, and authorization for publication of statements, conclusions or extracts from or regarding our reports is reserved pending our written approval. Test results apply specifically to the samples tested only. The entire report shall not be reproduced, except in full, without the written approval of the laboratory. Samples will be disposed of after testing is completed unless other arrangements are agreed to in writing.

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 187586
Sample Name: VR-B15-0-24 EAST
Sample Date: 09/17/97
Collected by: SCOTT COLVIN
Time Sampled: 1030
Sample Type: SOIL

PARAMETER	MEASURED VALUE		METHOD NUMBER	DATE ANALYZED
SOIL				
Acid Potential	6	tons/1000 ton	SOBEK	10/15/97
Acid/Base Potential	-6	tons/1000 ton	SOBEK	10/15/97
Neutralization Potential	<1	tons/1000 ton	SOBEK	10/10/97
pH Saturated Paste	4.5	S.U.	S-1.10	10/10/97
SMP Buffer pH	5.3	S.U.	S-2.50	09/25/97
Sulfur (Total Eschka)	0.3	%	D3987	09/30/97
Sulfur, HCl Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, HNO3 Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, Residual	0.2	%	SOBEK	10/01/97
Sulfur, Water Extractable	0.1	%	SOBEK	10/01/97

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 187587
Sample Name: VR-C18-0-24
Sample Date: 09/17/97
Collected by: SCOTT COLVIN
Time Sampled: 1115
Sample Type: SOIL

PARAMETER	MEASURED VALUE		METHOD NUMBER	DATE ANALYZED
SOIL				
Acid Potential	81	tons/1000 ton	SOBEK	10/15/97
Acid/Base Potential	-81	tons/1000 ton	SOBEK	10/15/97
Neutralization Potential	<1	tons/1000 ton	SOBEK	10/10/97
pH Saturated Paste	4.0	S.U.	S-1.10	10/10/97
SMP Buffer pH	4.8	S.U.	S-2.50	09/25/97
Sulfur (Total Eschka)	2.7	%	D3987	09/30/97
Sulfur, HCl Extractable	0.4	%	SOBEK	10/01/97
Sulfur, HNO3 Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, Residual	2.3	%	SOBEK	10/01/97
Sulfur, Water Extractable	0.3	%	SOBEK	10/01/97

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 187588
Sample Name: VR-C19-0-24 EAST
Sample Date: 09/17/97
Collected by: SCOTT COLVIN
Time Sampled: 1330
Sample Type: SOIL

PARAMETER	MEASURED VALUE		METHOD NUMBER	DATE ANALYZED
SOIL				
Acid Potential	16	tons/1000 ton	SOBEK	10/15/97
Acid/Base Potential	-16	tons/1000 ton	SOBEK	10/15/97
Neutralization Potential	<1	tons/1000 ton	SOBEK	10/10/97
pH Saturated Paste	4.0	S.U.	S-1.10	10/10/97
SMP Buffer pH	4.7	S.U.	S-2.50	09/25/97
Sulfur (Total Eschka)	0.8	%	D3987	09/30/97
Sulfur, HCl Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, HNO3 Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, Residual	0.5	%	SOBEK	10/01/97
Sulfur, Water Extractable	0.4	%	SOBEK	10/01/97

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 187589
Sample Name: VR-B26-0-24
Sample Date: 09/17/97
Collected by: SCOTT COLVIN
Time Sampled: 1400
Sample Type: SOIL

PARAMETER	MEASURED VALUE		METHOD NUMBER	DATE ANALYZED
SOIL				
Acid Potential	220	tons/1000 ton	SOBEK	10/15/97
Acid/Base Potential	-220	tons/1000 ton	SOBEK	10/15/97
Neutralization Potential	<1	tons/1000 ton	SOBEK	10/10/97
pH Saturated Paste	3.1	S.U.	S-1.10	10/10/97
SMP Buffer pH	3.7	S.U.	S-2.50	09/25/97
Sulfur (Total Eschka)	6.6	%	D3987	09/30/97
Sulfur, HCl Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, HNO3 Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, Residual	7.0	%	SOBEK	10/01/97
Sulfur, Water Extractable	0.6	%	SOBEK	10/01/97

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 187590
Sample Name: VR-U5.5-0-24
Sample Date: 09/18/97
Collected by: SCOTT COLVIN
Time Sampled: 0930
Sample Type: SOIL

PARAMETER	MEASURED VALUE		METHOD NUMBER	DATE ANALYZED
SOIL				
Acid Potential	12	tons/1000 ton	SOBEK	10/15/97
Acid/Base Potential	-12	tons/1000 ton	SOBEK	10/15/97
Neutralization Potential	<1	tons/1000 ton	SOBEK	10/10/97
pH Saturated Paste	5.2	S.U.	S-1.10	10/10/97
SMP Buffer pH	5.9	S.U.	S-2.50	09/25/97
Sulfur (Total Eschka)	0.4	%	D3987	09/30/97
Sulfur, HCl Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, HNO3 Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, Residual	0.4	%	SOBEK	10/01/97
Sulfur, Water Extractable	0.1	%	SOBEK	10/01/97

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 187591
Sample Name: VR-C19.6
Sample Date: 09/19/97
Collected by: SCOTT COLVIN
Time Sampled: 1240
Sample Type: SOIL

PARAMETER	MEASURED VALUE		METHOD NUMBER	DATE ANALYZED
SOIL				
Acid Potential	77	tons/1000 ton	SOBEK	10/15/97
Acid/Base Potential	-77	tons/1000 ton	SOBEK	10/15/97
Neutralization Potential	<1	tons/1000 ton	SOBEK	10/10/97
pH Saturated Paste	3.8	S.U.	S-1.10	10/10/97
SMP Buffer pH	4.6	S.U.	S-2.50	09/25/97
Sulfur (Total Eschka)	3.2	%	D3987	09/30/97
Sulfur, HCl Extractable	0.6	%	SOBEK	10/01/97
Sulfur, HNO3 Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, Residual	2.0	%	SOBEK	10/01/97
Sulfur, Water Extractable	1.3	%	SOBEK	10/01/97

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 187592
Sample Name: VR-CD
Sample Date: NONE GIVEN
Collected by: SCOTT COLVIN
Time Sampled: NONE GIVEN
Sample Type: SOIL

PARAMETER	MEASURED VALUE		METHOD NUMBER	DATE ANALYZED
SOIL				
Acid Potential	73	tons/1000 ton	SOBEK	10/15/97
Acid/Base Potential	-73	tons/1000 ton	SOBEK	10/15/97
Neutralization Potential	<1	tons/1000 ton	SOBEK	10/10/97
pH Saturated Paste	3.9	S.U.	S-1.10	10/10/97
SMP Buffer pH	4.7	S.U.	S-2.50	09/25/97
Sulfur (Total Eschka)	3.0	%	D3987	09/30/97
Sulfur, HCl Extractable	0.7	%	SOBEK	10/01/97
Sulfur, HNO3 Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, Residual	1.8	%	SOBEK	10/01/97
Sulfur, Water Extractable	1.2	%	SOBEK	10/01/97

Client Name: MAXIM - HELENA, MT
Project No.: 87-911
Laboratory No.: 187593
Sample Name: DUPLICATE 187586 VR-B15-0-24 EAST
Sample Date: 09/17/97
Collected by: SCOTT COLVIN
Time Sampled: 1030
Sample Type: SOIL

PARAMETER	MEASURED VALUE		METHOD NUMBER	DATE ANALYZED
SOIL				
Acid Potential	6	tons/1000 ton	SOBEK	10/15/97
Acid/Base Potential	-6	tons/1000 ton	SOBEK	10/15/97
Neutralization Potential	<1	tons/1000 ton	SOBEK	10/10/97
pH Saturated Paste	4.5	S.U.	S-1.10	10/10/97
SMP Buffer pH	5.3	S.U.	S-2.50	09/25/97
Sulfur (Total Eschka)	0.3	%	D3987	09/30/97
Sulfur, HCl Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, HNO3 Extractable	<0.1	%	SOBEK	10/01/97
Sulfur, Residual	0.2	%	SOBEK	10/01/97
Sulfur, Water Extractable	0.1	%	SOBEK	10/01/97

ATTACHMENTS

MAXIM TECHNOLOGIES INC

SAMPLE RECEIPT CHECKLIST

Client Name: M-Helena

Project: Streamwise Tailings RR Materials

Laboratory number(s): 187586-92

Checklist completed by: [illegible] 9/23 (Initials / Date)

Date/Time Received: 9/23/97 0920 (Date / Time)

Received by: [illegible]

Carrier name: UPS

Sample Type: Soil

		YES	NO
1.	Shipping container in good condition?	✓	
2.	Custody seals present on shipping container?		✓
3.	Condition: Intact _____ Broken _____		
4.	Chain of custody present?	✓	
5.	Chain of custody signed when relinquished and received?	✓	
6.	Chain of custody agrees with sample labels?	✓	
7.	Custody seals on sample bottles?		✓
8.	Condition: Intact _____ Broken _____		
9.	Samples in proper container/bottle?	✓	
10.	Samples intact?	✓	
11.	Sufficient sample volume for indicated test?	✓	
12.	VOA vials have zero headspace?	NA	
13.	Trip Blank received?		✓
14.	Ice/Frozen Blue Ice present in shipping container? (circle one)	~~✓~~	✓
15.	Container temperature 1. 15.6°C 2. _____ 3. _____		

		YES	NO
16.	All samples rec'd within holding time?	✓	
	Preservation		
17.	pH check performed by: _____		
18.	Metals bottle(s) pH <2?	NA	
19.	Nutrient bottle(s) pH <2?		
20.	Cyanide bottle(s) pH >12?		
21.	Sulfide bottle(s) pH >9?		
22.	Oil & grease bottle(s) pH <2?		
23.	TOC bottle(s) pH <2?		
24.	DRO/418.1 bottle(s) pH <2?		
25.	Phenolics bottle(s) pH <2?		✓
26.	Volatiles (VOA) pH <2? (VOA pH checked by analyst)	NA	
27.	Client contacted?		
28.	Person contacted		
29.	Date contacted		
30.	Contacted by		
31.	Regarding?		

Note: Samples may be affected when not transported at the temperature recommended by the EPA for the test you've selected. Please contact the lab if you have concerns about the temperature of your samples.

COMMENTS: _____

CHAIN OF CUSTODY RECORD

MAXIM TECHNOLOGIES INC

Project or Site Name: Sams to Railroad Materials

Project Number: S609702728-07

Sampler Name (Printed): SCOTT CORVIN

☐ Billings, MT ☒ Helena, MT
☐ Boise, ID ☐ Missoula, MT
☐ Great Falls, MT ☐ Yakima, WA

Contact or Report to: MIKE CORMIER

Contact Address or Location: Helena

Sampler Signature: Scott Corvin

DATE COLLECTED	TIME COLLECTED	SAMPLE LOCATION OR DESCRIPTION	COMP OR GRAB	SAMPLE MATRIX	NO. OF CONTAINERS	ANALYSIS REQUIRED: PH, ABA & SMP	NOTES	LAB NUMBER (C 9/23/97)
9/17/97	1030	VR-B15-0-24 EAST	Comp	Soil	1	1		187586
"	1115	VR-C18-0-24	"	"	1	1		87
"	1330	VR-C19-0-24 EAST	"	"	1	1		88
"	1400	VR-B26-0-24	"	"	1	1		89
9/18/97	0930	VR-U5.5-0-24	"	"	1	1		90
9/19/97	1240	VR-C19.6	"	"	1	1		91
N/A	N/A	VR-CD	"	"	1	1		92
							DUP 187586 VR-B15-0-24 East 9/17 1030	93
							SP 187591 VR-C19.6 9/19 1240	94

	Date	Time	Received by:
Relinquished by: Scott Corvin	9/22/97	1400	UPS
Relinquished by: UPS	9/23/97	0900	
Relinquished by:	Date	Time	Received by:
Relinquished by:	Date	Time	Received by:

Remarks:
pH, ABA & SMP analysis - parameter method list enclosed

Cooler temp 15.6°C

APPENDIX K-3

Rock Cover Volume Estimates for Railroad Materials Remediation

SST OU, SUBAREA 1, SILVER BOW CREEK Reach A

Railroad Materials Remediation

	B1/B2	B3	B3.1	B3.2	B3.3	B4	B5	B6	B7
Approximate Length	140	60	115	74	45	20	13	27	290
Approximate Width	12	11	12	10	15	13	13	13	12
Approximate Area	1680	660	1380	740	675	260	169	351	3480
Exposed to Flood Flows?	No	No	No	No	No	No	No	No	No
Approximate Elevation of 100-year Flood									
Approximate Elevation of Top of Embankment									
Potential for Overtopping?									
Approximate Flow Velocity									
Approximate Scour Elevation									
Average Flow Depth									
Nominal Riprap Diameter Size - D50 (Inches)									
Bottom Elevation of Riprap									
Top Elevation of Riprap									
Approximate Area of Filter Fabric Needed									
Class I									
Class II & III									
Approximate Volume of Rock Cover Needed	55	25	45	25	25	10	10	15	110
Approximate Volume of Riprap Needed									
Class I									
Class II									
Class III									
Approximate Area to be Lime Amended and Vegetated									
Approximated Volume of General Fill Needed									
Approx Vol of Waste Mat'l to be Excvd & Disposed	15	1	2	1	1	0.5	0.5	0.5	5
Comments									

	B8	B9	B10	B11	B12	B13S	B13N	B14S	B14N	B15
Approximate Length	140	35	480	1800	210	420	420	360	360	100
Approximate Width	24	6	20	30	21	26	25	31	17	32
Approximate Area	3360	210	9600	54000	4410	11024	10634	11160	6120	3200
Exposed to Flood Flows?	No	No	No	No	No	YES	No	YES	No	YES
Approximate Elevation of 100-year Flood						5390		5390		5385
Approximate Elevation of Top of Embankment										5384
Potential for Overtopping?						No		No		YES
Approximate Flow Velocity						1.2		1		see comments
Average Flow Depth						2		2		11
Approximate Scour Elevation										5373
Nominal Riprap Diameter Size - D50 (Inches)						0.03665641554		0.02121320344		see comments
Bottom Elevation of Riprap										5373
Top Elevation of Riprap										top of bank
Approximate Area of Filter Fabric Needed										
Class I										1840
Class II & III										230
Approximate Volume of Rock Cover Needed	100	10	280	1500	130	310	300	310	180	
Approximate Volume of Riprap Needed										
Class I										50
Class II										25
Class III										
Approximate Area to be Lime Amended and Vegetated										
Approximated Volume of General Fill Needed										
Approx Vol of Waste Mat'l to be Excvd & Disposed	5	1	10	100	15	10	25	10	20	5
Comments						use 6"-minus rock		use 6"-minus rock		80 Cl III riprap on abut; Cl I on rest.

SST OU, SUBAREA 1, SILVER BOW CREEK Reach A

Railroad Materials Remediation

	U1	U2	U3	U4	U5	U5.5	U5.6	U6
Approximate Length	93	50	1100	860	330	30	410	26
Approximate Width	40	21	20	65	37	25	30	14
Approximate Area	3720	1050	22000	55900	12210	750	12300	364
Exposed to Flood Flows?	No			YES	YES	YES	YES	No
Approximate Elevation of 100-year Flood				5385.1	5385.1	5385.1	5385.1	
Approximate Elevation of Top of Embankment				5388 - 5384	5388	5388	5388 - 5386	
Potential for Overtopping?				on d/s end	Maybe	No	No	
Approximate Flow Velocity				0	6.4	6.4	0	
Average Flow Depth				6	10	10	6	
Approximate Scour Elevation					5373	5373		
Nominal Riprap Diameter Size - D50 (Inches)					2.48691634484	2.48691634484		
Bottom Elevation of Riprap					5373	5373		
Top Elevation of Riprap					top of bank	top of bank		
Approximate Area of Filter Fabric Needed Class I Class II & III					6600	900		
Approximate Volume of Rock Cover Needed	105	30		410	230		350	15
Approximate Volume of Riprap Needed Class I Class II Class III					190	20		
Approximate Area to be Lime Amended and Vegetated				43000				
Approximated Volume of General Fill Needed						1		
Approx Vol of Waste Mat'l to be Excvd & Disposed				35	420	25	10	5
Comments	portions are subject to drainage flows	portions are subject to drainage flows	no treatmt	slope has 6"-minus rock; top area is amended and vegetated	entire embank is waste u/s side is Cl I riprap; rest is 6"-minus	u/s side is Cl I riprap		

APPENDIX L

MPDES STORMWATER EROSION CONTROL PLAN

Final Design Report - Reach A Subarea 1
Streamside Tailings Operable Unit
Remedial Design

MPDES STORMWATER
EROSION CONTROL PLAN
FOR REMEDIAL CONSTRUCTION ACTIVITIES

STREAMSIDE TAILINGS
OPERABLE UNIT
SILVER BOW CREEK

Prepared for

Montana Department of Environmental Quality
Mine Waste Cleanup Bureau
2209 Phoenix Ave.
Helena, Montana 59620

Prepared by

Maxim Technologies, Inc.
P.O. Box 4699
1610 B Street
Helena, Montana 59604

February 1998

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1.0 PROJECT DESCRIPTION

The purpose of this Plan is to provide a framework for erosion control measures to be implemented by the Contractor during remedial construction activities at the Streamside Tailings Operable Unit (SSTOU). Delineation of the four subareas which comprise the SSTOU and their individual characteristics as well as detailed maps are contained in the SSTOU Remedial Investigation (RI) Report (ARCO, 1995a). A detailed presentation of the SSTOU history is also provided in the SSTOU RI Report. Constituents of Concern (COC) contained in streamside tailings/impacted soils, in-stream sediments and railroad materials in or proximal to Silver Bow Creek include the following inorganic elements (MDEQ, 1995a; MDEQ 1996a):

- arsenic (As);
- cadmium (Cd);
- copper (Cu);
- lead (Pb);
- mercury (Hg); and,
- zinc (Zn)

Remediation of the streamside tailings/impacted soils, in-stream sediments and railroad materials containing COC within the SSTOU will be coordinated and performed according to the SSTOU Record of Decision (ROD) and Unilateral Administrative Order for Remedial Design and Remedial Action (UAORDRA).

1.1 PROJECT LOCATION

The SSTOU is located along Silver Bow Creek in Silver Bow and Deer Lodge Counties, Montana. Silver Bow Creek originates in Butte, Montana at the confluence of the Metro Storm Drain and Blacktail Creek and is the headwaters of the Clark Fork River. The upstream boundary of the SSTOU is the Lower Area One (LAO) portion of the Butte Priority Soils OU and the downstream boundary of the SSTOU is the Interstate 90 bridge directly upstream of the Warm Springs Ponds OU northeast of Opportunity. The Rocker Timber Framing and Treatment Plant OU, located in Rocker, Montana, is located partially within the SSTOU. The total length of the SSTOU is approximately 25 miles.

1.2 TYPE OF DISTURBANCE

Anticipated remediation construction activities performed within the SSTOU will include stream diversion channel and headgate/diversion structure, tailings/impacted soils removal and haul road construction, stream diversion and groundwater dewatering, in-stream sediment removal, mine waste relocation repository construction, borrow area excavation, floodplain backfill, stream channel construction and railroad materials remediation.

1.2.1 Soil Material Characteristics

Soils in the SSTOU consist of poor- to well-graded sands and gravels, low plasticity silts and some silty and clayey sands (ARCO, 1994a). Tailings/impacted soils consist of sand, silt and clay (ARCO, 1994a). As of the date of this Plan, United States Department of Agriculture Natural Resource Conservation Service (USDA NRCS) soil surveys for Silver Bow and Deer Lodge counties were unavailable.

1.3 POTENTIAL RECEIVING WATER

Construction activities will disturb Silver Bow Creek as well as wetland areas classified by the Corps of Engineers (COE) as wetlands (wetland and riparian areas) and non-wetlands in the vicinity of and upland of Silver Bow Creek.

1.3.1 Wetland & Non-wetland Areas

Wetland and non-wetland areas included in the SSTOU are indicated on site maps and discussed in the *Wetlands and Threatened/Endangered Species Inventory with Determination of Effective Wetland Area Report* (ARCO, 1994). The COE wetland area definition is provided below:

- *Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions (i.e. swamps, marshes and bogs).*

2.0 CONSTRUCTION SEDIMENT & EROSION CONTROL PROCEDURES

The purpose of this Plan is to protect surface water by minimizing erosion of disturbed areas during remediation construction activities within the SSTOU Project. The U.S. Environmental Protection Agency (EPA) and the Montana Department of Environmental Quality (MDEQ) require construction activities meet the following objectives to limit and control erosion (EPA, 1992a; MDEQ, 1996b):

- Preserve as much natural vegetation as possible.
- Minimize soil exposure time.
- Prevent runoff from flowing across disturbed areas.
- Stabilize disturbed soils as soon as possible.
- Minimize runoff rate across the site.
- Provide drainage for increased runoff.
- Remove sediment from stormwater runoff before it leaves the site.

This Plan describes the management practices which may be implemented during remediation construction activities to meet the objectives stated above. Because of the size of the construction area, this Plan does not identify specific sediment and erosion control features. The Contractor will be responsible for implementing appropriate sediment and erosion control measures. A suitable combination of Best Management Practices (BMPs) referenced in this section as well as additional BMPs included in the MDEQ *Montana Sediment and Erosion Control Manual, May 1996* will be employed to control sediment and erosion throughout the seven anticipated construction phases:

- PHASE 1: Tailings/Impacted Soils Removal and Haul Road Construction
- PHASE 2: Stream Diversion and Groundwater Dewatering
- PHASE 3: Mine Waste Relocation Repository Construction
- PHASE 4: Borrow Area Excavation
- PHASE 5: Floodplain Backfill
- PHASE 6: Stream Channel Construction
- PHASE 7: Railroad Materials Remediation

Sediment and erosion control BMPs which may be utilized include: preserving natural vegetation, stabilized construction entrances, dust control, surface roughening, check dams, vegetative, bioengineering and/or structural stream bank stabilization, filter fences, straw bale barriers and general good-housekeeping. BMPs referenced in this section are described in Section 4.0 of this Plan. The following sections describe erosion control measures to be implemented during each phase of construction.

2.1 TAILINGS/IMPACTED SOILS REMOVAL & HAUL ROAD CONSTRUCTION

This construction phase includes:

- Removal of tailings/impacted soils from stream bank and floodplain deposits;
- Removal of instream sediments in areas disturbed by new channel construction; and,

- Haul road construction.

Tailings/impacted soils removal will take place during construction of the stream diversion ditch and groundwater dewatering trenches. Saturated tailings/impacted soils encountered during removal will be stockpiled and dewatered prior to transport to the mine waste relocation repository.

Haul roads will be constructed within and adjacent to the impacted floodplain. In areas of tailings/impacted soils, the contaminated material will be removed and disposed as described above. Clean construction material will be used to construct haul roads. Culvert crossings will be installed at stream crossings and stream diversion channel crossings.

Structural erosion control measures may include dust control and stabilized construction entrances. Sediment retention practices may include filter fence and straw bales. See Section 4.0 for more detailed descriptions of sediment controls.

2.2 STREAM DIVERSION & GROUNDWATER DEWATERING

Stream diversion will likely be accomplished by redirecting stream flow into an open and riprap lined channel designed to pass the peak flow from the 10-year flood event for Silver Bow Creek (approximately 610 cubic feet per second). Groundwater dewatering will be accomplished through a system of open trenches pumped out through downgradient sumps. Sediment laden groundwater will be routed to sediment retention structures to remove sediment.

Tailings/impacted soil materials at the diversion or trench location will be excavated, dewatered and disposed as described in Section 2.1. Clean material will be stockpiled or placed in adjacent berms until reclamation of the dewatering trenches is complete.

Structural erosion control measures may include dust control and stabilized construction entrances. Sediment retention practices may include filter fence and straw bales. See Section 4.0 for more detailed descriptions of sediment controls.

2.3 MINE WASTE RELOCATION REPOSITORY CONSTRUCTION

Tailings/impacted soils will be transported to a MWRR using haul trucks and placed using heavy equipment. In-place tailings will be dewatered prior to removal to allow transport without spillage and placement in the repositories before further drying.

Structural erosion control measures may include dust control and stabilized construction entrances. Sediment retention practices may include filter fence and straw bales. See Section 4.0 for more detailed descriptions of sediment controls.

2.4 BORROW AREA EXCAVATION

Borrow areas have been identified to provide backfill materials in areas where tailings/impacted soils are removed. Borrow area materials will be excavated using heavy equipment and transported using haul trucks. Borrow areas will be reclaimed following excavation.

Structural erosion control measures may include dust control and stabilized construction entrances. Sediment retention practices may include filter fence and straw bales. See Section 4.0 for more detailed descriptions of sediment controls.

2.5 FLOODPLAIN BACKFILL

Areas where tailings/impacted soils material was removed from the floodplain will be backfilled with clean borrow material transported from borrow areas using haul trucks and placed using heavy equipment. Placed backfill material will be graded and revegetated.

Structural erosion control measures may include dust control and stabilized construction entrances. Sediment retention practices may include filter fence and straw bales. See Section 4.0 for more detailed descriptions of sediment controls.

2.6 STREAM CHANNEL CONSTRUCTION

Stream channel excavation will be accomplished using heavy equipment. New stream banks will be graded, stabilized with mesh fabric and revegetated. In general, new stream banks will be constructed in dry locations. Where this is not possible, the construction area will be isolated from flowing water using barriers or check dams.

Structural erosion control measures may include dust control and stabilized construction entrances. Sediment retention practices may include filter fence and straw bales. See Section 4.0 for more detailed descriptions of sediment controls.

2.7 RAILROAD MATERIALS REMEDIATION

Railroad materials remediation inside the SSTOU will include covering embankment waste areas, with rock material. The rock material will be transported by trucks and placed with heavy equipment. Railroad materials remediation outside the SSTOU will include the construction of sediment basins. The basins will be constructed with heavy equipment.

Structural erosion control measures may include dust control and stabilized construction entrances. Sediment retention practices may include filter fence and straw bales. See Section 4.0 for more detailed descriptions of sediment controls.

3.0 WETLAND SEDIMENT & EROSION CONTROL PROCEDURES

Table 1 provides additional sediment and erosion control procedures which may be employed when construction activities cross COE wetlands which are to remain undisturbed. COE wetland and non-wetland areas included in the SSTOU are located and discussed in the *Wetlands and Threatened/Endangered Species Inventory with Determination of Effective Wetland Area Report* (ARCO, 1994).

TABLE 1

ADDITIONAL SEDIMENT & EROSION CONTROL PROCEDURES AT UNDISTURBED WETLAND CROSSINGS

SSTOU

All equipment will be cleaned and inspected prior to entering a wetland. No leaking equipment will be allowed in wetland areas.
Appropriate sediment barriers will be implemented (Section 4.0 of this Plan)
Construction and vehicular access will be strictly limited across wetland areas.
The construction activity disturbance area will be minimized.
No construction activities will occur within wetland areas unless required by tailings/impacted soils material removal activities.
At a minimum, wooden mats or boards will be placed in undisturbed wetland crossing areas to reduce vehicular travel impacts to wetland vegetation and soils. All construction equipment and vehicles will be restricted to these mats at undisturbed wetland crossings.
All construction mats and other materials as well as materials from clearing and grading activities will be removed from the wetland area.

4.0 BEST MANAGEMENT PRACTICES FOR SEDIMENT & EROSION CONTROL

A suitable combination of BMPs described in this section as well as additional BMPs included in the MDEQ *Montana Sediment and Erosion Control Manual, May 1996* will be employed during the construction phases summarized in Section 2.0. The BMPs described in this section are designed to maximize vegetated areas, minimize soil exposure, control runoff, stabilize slopes, and reduce sediment runoff. Factors such as the presence of saturated soils or receiving water, the presence of natural vegetation, percent slope, and soil stability will determine which combination of BMPs is most appropriate to achieve the sediment and erosion control objectives listed in Section 2.0 of this Plan.

4.1 PERMANENT COVER PRACTICES

Permanent cover practices will be implemented to the extent practicable during all phases of remediation construction.

4.1.1 Preserve Natural Vegetation

Natural vegetation may be preserved to reduce erosion during all construction phases. Natural vegetation may be preserved on steep slopes, near perennial or ephemeral drainages or swales.

4.2 STRUCTURAL EROSION CONTROL PRACTICES

Structural erosion control practices will be implemented to the extent practicable during all phases of remediation construction.

4.2.1 Stabilized Construction Entrances

Construction road entrances and exits onto paved roads may be temporarily stabilized with crushed stone immediately following grading to reduce erosion of the road bed during wet weather and reduce tracking on paved road surfaces.

4.2.2 Dust Control

Dust control may be implemented along haul routes as well as in remediation construction area to limit fugitive dust. Haul roads and remediation construction areas will be sprinkled with water as needed and soil exposure time will be minimized.

4.2.3 Surface Roughening

A rough soil surface with horizontal depressions may be created on the disturbed soil contour using heavy equipment (i.e. disking, harrowing) or slopes may remain in a roughened condition without fine grading. This BMP may be utilized on slopes steeper than 3:1 and greater than 5 vertical feet.

4.2.4 Check Dams

Temporary check dams may be constructed across swales or ditches to reduce the velocity of concentrated flows. No check dams will be placed across streams unless approved by the State Department of Fish Wildlife and Parks and possibly other entities. Check dams will be constructed according to guidelines presented in the MDEQ *Montana Sediment and Erosion Control Manual, May 1996.*

4.2.5 Vegetative, Bioengineering and/or Structural Stream Bank Stabilization

Stream bank stabilization techniques using vegetative, bioengineering and structural means will be utilized along Silver Bow Creek throughout SSTOU to reduce flood flow velocities.

4.3 SEDIMENT RETENTION PRACTICES

Structural erosion control practices will be implemented to the extent practicable during all phases of remediation construction.

4.3.1 Filter Fence

Temporary filter fence may be installed where necessary to intercept or detain small amounts of sediment from disturbed areas as a result of sheet or overland flows and low-to-moderate level channel flow. Silt fences will be used along stream banks between disturbed areas and the stream, around stockpiled spoils and perpendicular to minor swales or trench lines.

Filter fence may be used in conjunction with other control measures. The base of the fabric will be keyed in and backfilled at least 6 inches into the ground on the upslope side of the barrier. Fence sections should be overlapped at least six inches when two sections are joined.

4.3.2 Straw Bale Barriers

Straw bale barriers may be installed as a temporary measure below disturbed areas subject to sheet erosion and in minor swales and drainages to intercept and detain small amounts of sediment. Straw bale barriers may also be used in conjunction with filter fences. Straw bales will be placed perpendicular to the expected runoff direction with the bases at a minimum of four inches into the soil. The straw bale bindings will be horizontal. Each straw bale will be securely anchored with two stakes or re-bars driven in flush with the top of the bale.

4.4 GOOD HOUSEKEEPING PRACTICES

The following control measures will be implemented to prevent or minimize potentially polluting construction materials from contact with stormwater:

- Train employees in good housekeeping techniques to reduce the likelihood of possible chemical or equipment mishandling.
- Inspect fuel storage containers for leaks or conditions which could lead to discharges of hydrocarbons to stormwater.
- Inspect culverts on a routine basis.
- Repair or replace defective equipment found during inspections.
- Adjust, repair or replace operational equipment such as vehicles, pipes, pumps and check valves as needed to prevent breakdown which could result in contamination of surface water.
- Maintain regular garbage, rubbish, construction waste and sanitary waste disposal.

- Protect chemicals, paints, solvents, fuel, and any other potentially toxic materials in adequate storage areas.

5.0 MONITORING, RECORDING & REPORTING

5.1 INSPECTIONS

During remediation construction, qualified Contractor personnel will inspect disturbed areas, structural control measures, and locations where vehicles access construction areas at least once every seven calendar days and within 24 hours of any precipitation event which exceeds 0.5 inches. During stormy periods when runoff occurs daily, erosion control facilities will be inspected daily.

If sediment is observed in stormwater leaving a construction area or discharging to surface water, corrective action shall be taken within 24 hours to reduce sediment discharge.

5.2 REPORTING

An inspection report form will be prepared and signed by the Contractor's Representative following each inspection. This record will be available to the MDEQ upon request. Copies of the inspection reports will be retained in a field binder at the construction site.

Following completion of SSTOU remediation construction activities, all records and information resulting from sediment and erosion control monitoring activities will be retained by the Contractor for a minimum of three years. Copies of all records will be provided to the MDEQ upon request.

A copy of this Plan will be maintained by the Contractor at the Project site for the life of the remediation construction project.

6.0 REFERENCES

Environmental Protection Agency. 1992a. *Storm Water Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practices*. EPA Office of Water. September.

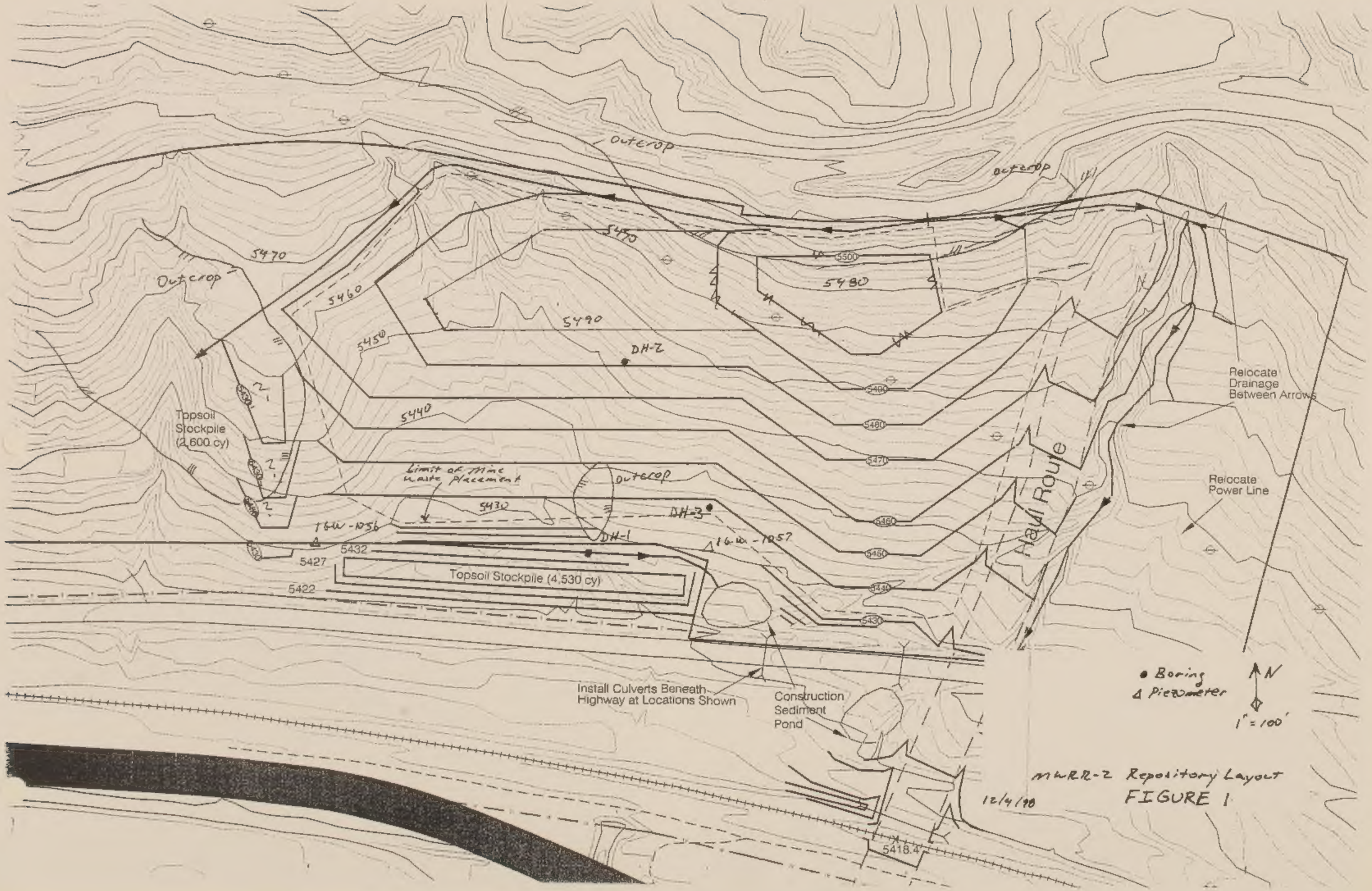
Atlantic Richfield Company. 1994a. Silver Bow Creek/Butte Area NPL Site. Streamside Tailings Operable Unit RI/FS. *Identification and Delineation of Jurisdictional Wetlands; Inventory of Threatened, Endangered and Sensitive Species*. July.

_____**1995a**. Silver Bow Creek/Butte Area NPL Site. Streamside Tailings Operable Unit Draft RI/FS. *Draft RI Report*. January.

Montana Department of Environmental Quality. 1995a. Silver Bow Creek/Butte Area NPL Site. Streamside Tailings Operable Unit. *Record of Decision*. November

_____**1996a**. Silver Bow Creek/Butte Area NPL Site. Streamside Tailings Operable Unit. *Unilateral Administrative Order for Remedial Design and Remedial Action*. March

_____**1996b**. *Montana Sediment and Erosion Control Manual*. Montana Pollutant Discharge Elimination System Program. May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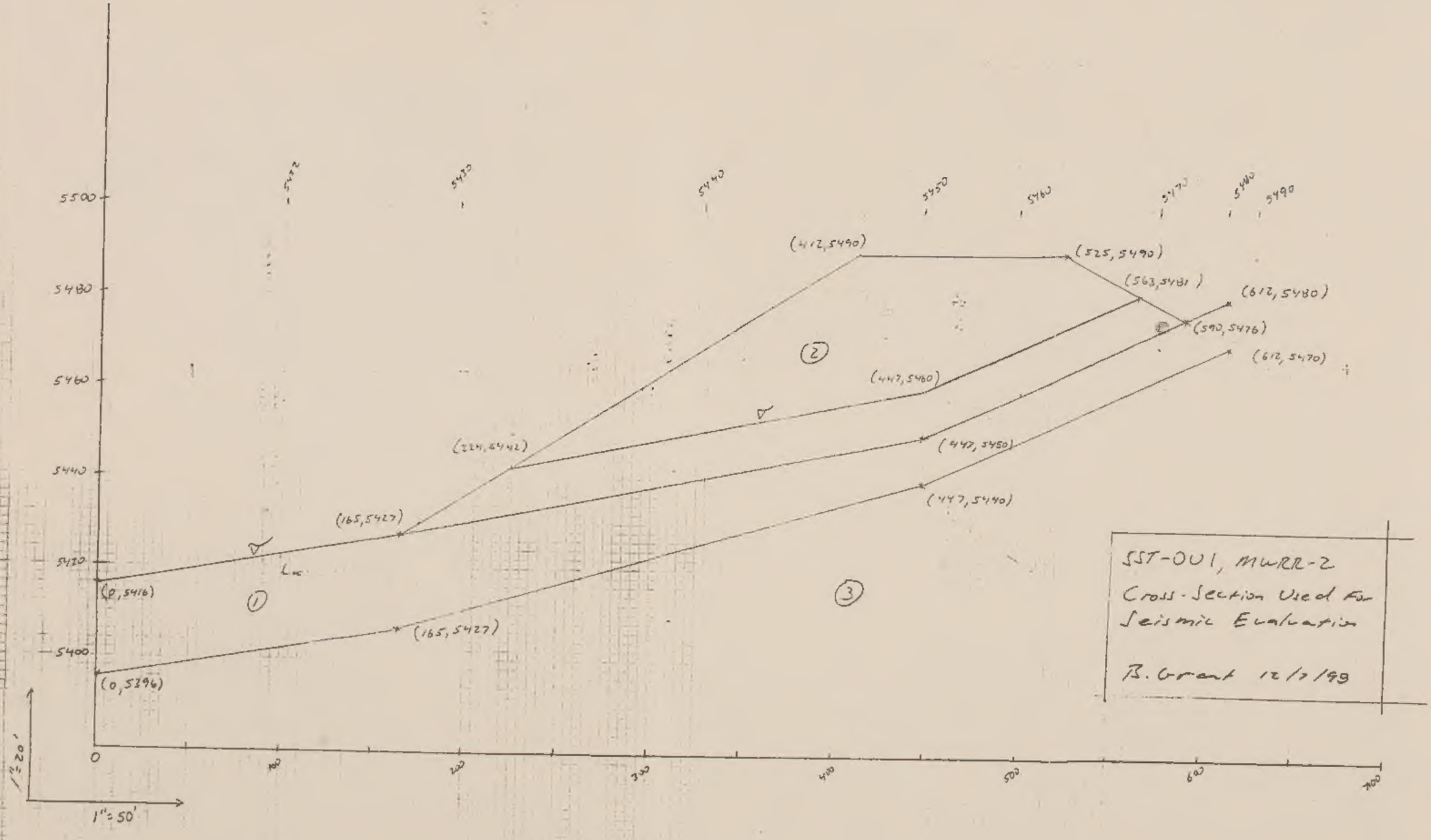
Topsoil
Stockpile
(2,600 cy)
Limit of Mine
Waste Placement
Outcrop
5430
DH-3
DH-1
TGW-105b
TGW-105a
5432
5427
5422
Topsoil Stockpile (4,530 cy)
Install Culverts Beneath
Highway at Locations Shown
Construction
Sediment
Pond
5418.4
Relocate
Drainage
Between Arrows
Relocate
Power Line
Alaska Route
• Boring
Δ Piezometer
N
1" = 100'
MWRR-2 Repository Layout
12/4/90
FIGURE 1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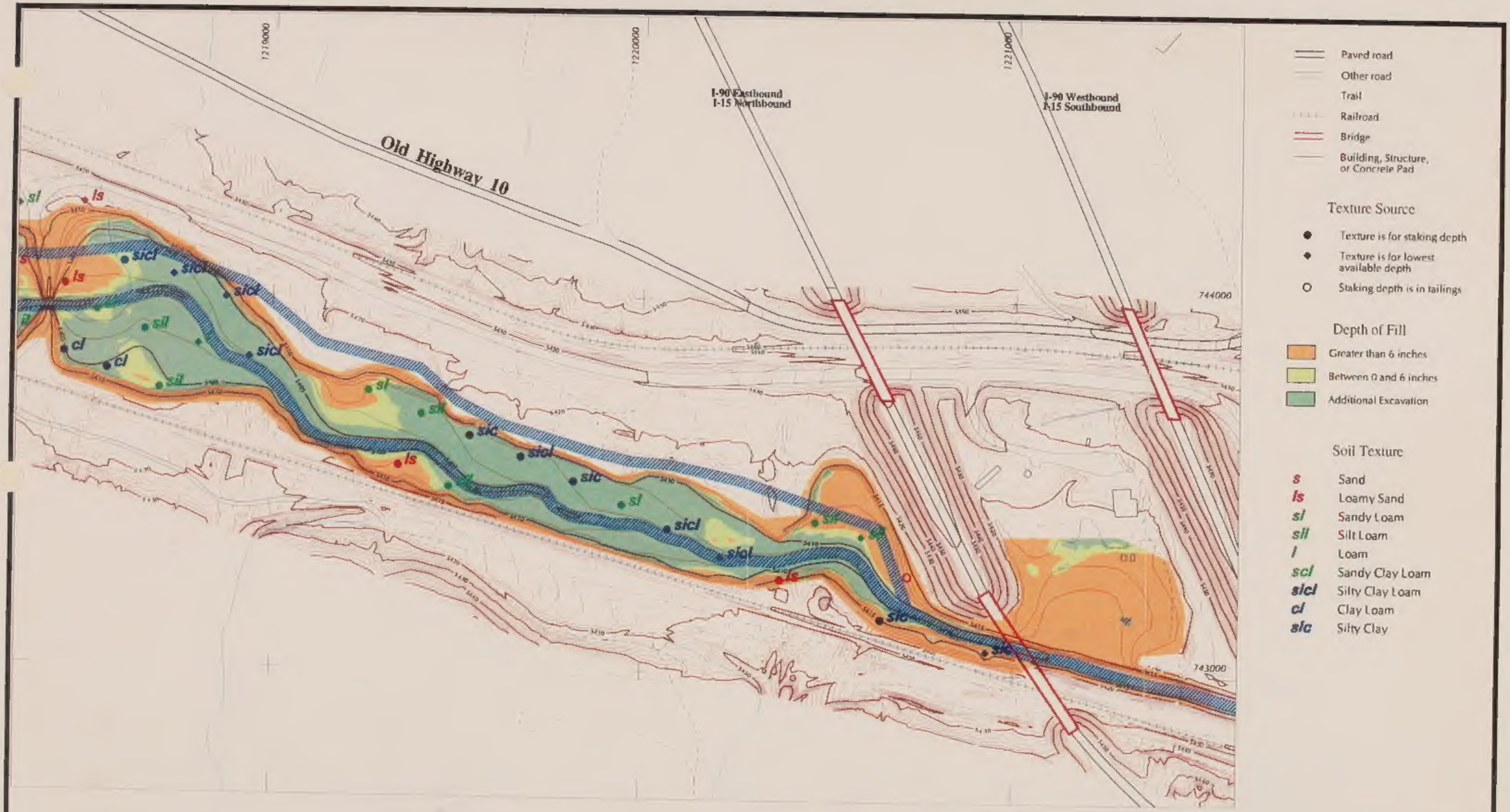
1" = 20'
1" = 50'
SST-001, MWRR-2
Cross-Section Used For
Seismic Evaluation
B. Grant 12/2/99



Montana State Library
Natural Resource Information System
Map #98deq36b - 06/15/99

Contour Interval 2 Feet
(1 foot in floodplain)
Scale in Feet
0 200 400 600 800

Sources:
Base map data was digitized by Horizons, Inc., of Rapid City, SD, from aerial photographs of 1991. Contours were digitized by Horizons in 1996. Proposed floodplain contours, location of Silver Bow Creek, and location of the drainage ditch were provided by Interfluve. Depth of fill and soil textures at the deepest excavation surface were estimated by NRIS using the Staking Plan and soil pit data from Maxim, proposed floodplain contours, and the proposed position of Silver Bow Creek. Horizon contours were used where where Interfluve contours were not available.

1,000-foot grid is for Montana State Plane Coordinates, South Zone, NAD27.

Staking Plan Soil Texture & Fill Depth
Preliminary Final Design
Streamside Tailings Operable Unit
Silver Bow Creek Subarea 1, Reach A

Figure J2 –A

Paved road
Other road
Trail
Railroad
Bridge
Building, Structure, or Concrete Pad

Texture Source

- Texture is for staking depth
- Texture is for lowest available depth
- Staking depth is in tailings

Depth of Fill

- Greater than 6 inches
- Between 0 and 6 inches
- Additional Excavation

Soil Texture

s	Sand
ls	Loamy Sand
sl	Sandy Loam
sil	Silt Loam
l	Loam
scl	Sandy Clay Loam
sicl	Silty Clay Loam
cl	Clay Loam
sic	Silty Clay

Montana State Library
Natural Resource Information System
Map #98deq36b - 06/15/99

Contour Interval 2 Feet
(1 foot in floodplain)
Scale in Feet
0 200 400 600 800

Sources:
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1,000-foot grid is for Montana State Plane Coordinates, South Zone, NAD27.

Staking Plan Soil Texture & Fill Depth
Preliminary Final Design
Streamside Tailings Operable Unit
Silver Bow Creek Subarea 1, Reach A

Figure J2 –B